6(b) - RF Troubleshooting and Manual Tuning Guide

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Introduction

This document describes troubleshooting and RF tuning of RH-51/52, RH-67/68. In general, two types of measurements have to be done during troubleshooting and repair of phones:

- RF measurements shall be done with a spectrum analyzer, either connected directly to the RF connector of the RF adapter board SA-29, or used together with a high-frequency probe to measure RF signals at points along the TX or RX chain.
- LF (Low-Frequency) and DC measurements shall be done either with a multimeter, or with an oscilloscope together with a 10:1 probe.

All tuning must be done with Phoenix Service Software 2004.32.2.58 or later.

Always make sure that the measurement set-up has been calibrated when measuring RF parameters at the RF connector. Remember to include the correct losses in the module repair jig and the connecting cable when realigning the phone.

Most RF semiconductors are static discharge sensitive. ESD protection must be taken into account during repair (ground straps and ESD soldering irons).

Helgo RF ASIC is moisture sensitive. Therefore, Helgo RF ASIC must be pre-baked prior to soldering unless it is stored in a sealed moisture barrier bag.

RF calibration done via Phoenix software is temperature sensitive because of calibration of 26MHz reference oscillator (VCXO). According to the Helgo specification, the ambient temperature has to be in the range of 22 to 36°C.

General troubleshooting

Note: In this text the following terms are used interchangeably:
GSM900 = EGSM900 = EGSM
GSM1800 = DCS band = PCN band
GSM1900 = PCS band

The first step of fault-finding should always be a visual inspection. Carefully inspect the RF area using a microscope and look for solder bridges, missing components, short circuits, components that have partially come off and other anomalies. Capacitors can be checked to see that they are not short-circuited, and inductors that they are not open circuits. Also check that power supply lines are not short-circuited, i.e. not 0Ω to ground.

Instruments needed for troubleshooting (minimum requirement):

- oscilloscope
- multimeter
- spectrum analyzer (SA)

Note:
Always use an attenuator at the spectrum analyzer input to ensure that the SA will not become damaged by excessive input power from the phone. Check the spectrum analyzer for maximum allowable input power.

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For example, when transmitting in the EGSM band at max power level, the output power will be around +33dBm. By using a 10dB attenuator the actual input to the SA will then be +23dBm. Also adjust the internal attenuator so that the transmitted signal is reduced to less than around -10dBm in order to avoid saturation of SA input stage.

- power supply that can deliver at least 2Adc
- Nokia MJ-25 module jig (also called test jig)
- RF adapter SA-29
- PC with Phoenix installed
- PKD-1 deskey dongle for Phoenix

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RF key component placement

The following figure shows the key components of the RF section.

Figure 1: RF key components

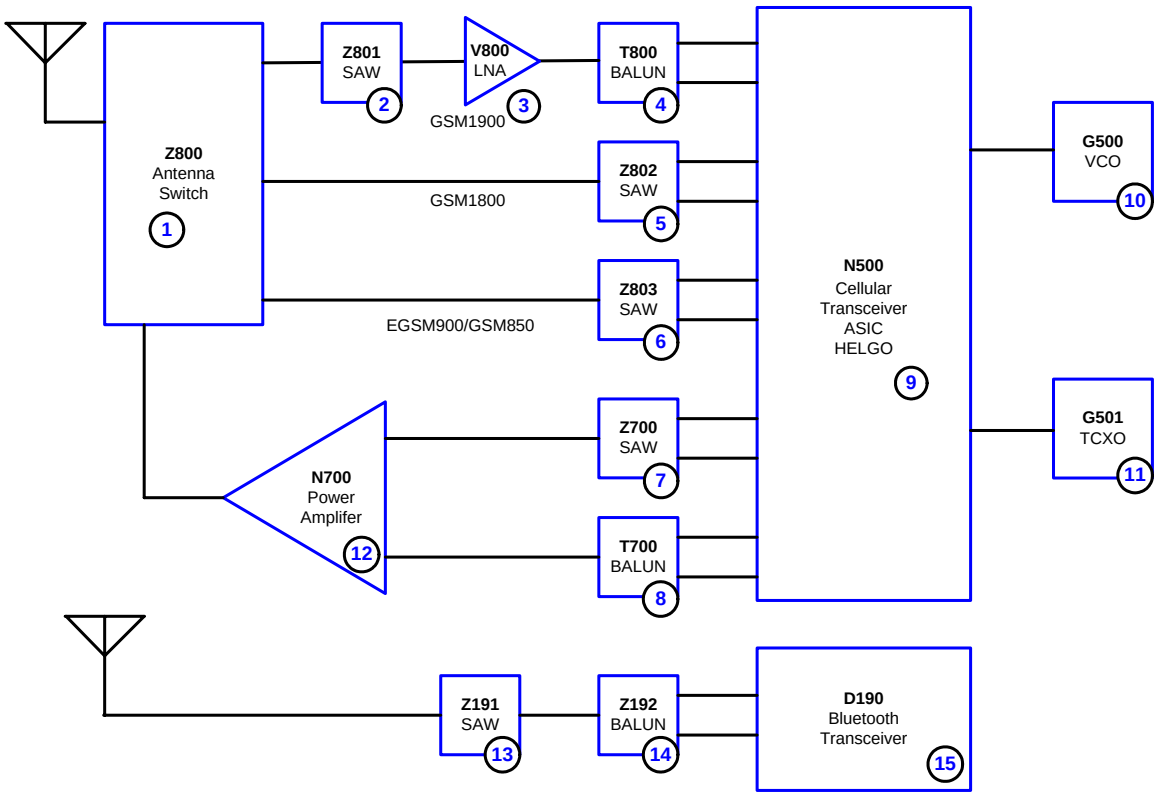
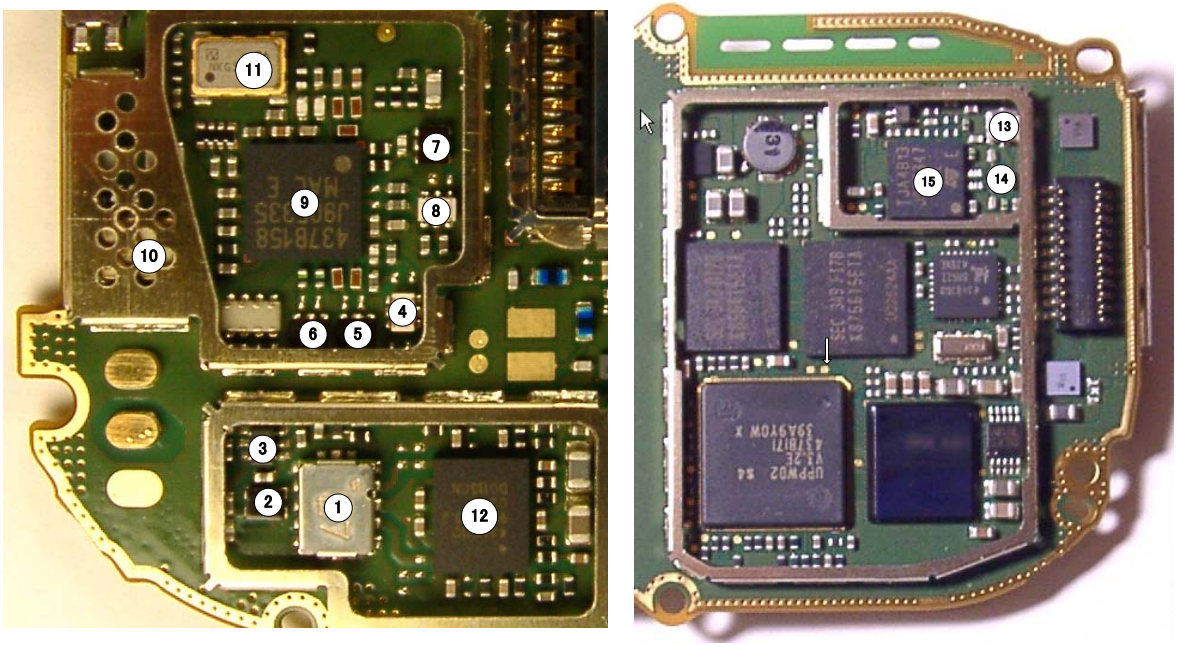


Figure 2: RF key components



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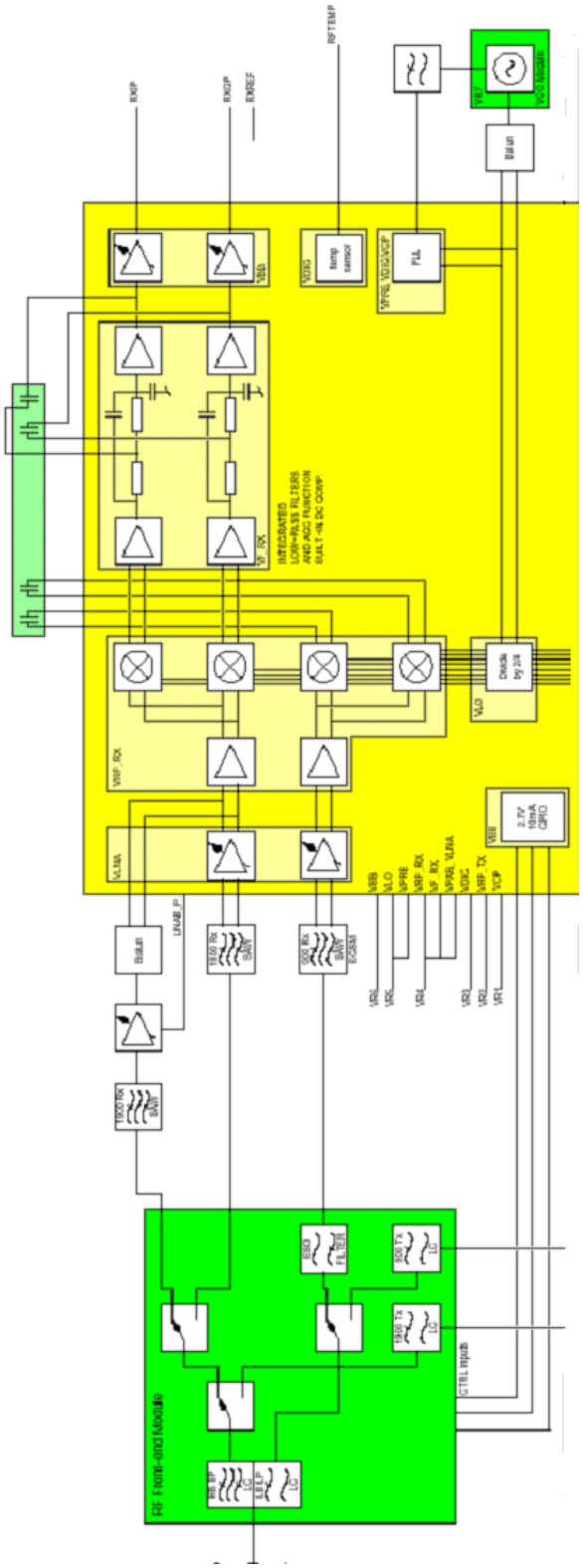
Receiver troubleshooting

General description

Figure 3: Receiver signal path



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Each receiver path is a direct conversion linear receiver. From the antenna, the received RF signal is fed to a front end module where a diplexer first divides the signal to two separate paths according to the band of operation: either lower, GSM850/EGSM900 or upper, GSM1800/1900 path. At each of the paths follows a pin-diode switch, which is used to select either a receive- or transmit mode. At the upper band in the receive mode either GSM1800 or 1900 path is further selected by another pin-diode switch. The selections are controlled by Helgo, which obtains the mode/band and timing information through the RFBus. After the switches an external bandpass filter follows each receiver paths. Thereafter, the signal is fed to the LNA's. GSM850/EGSM900 and GSM1800 LNA's are integrated in Helgo, while the GSM1900 LNA is a discrete component placed between SAW filter and balun. In GSM1900, the amplified signal is fed to a pre-gain stage of the mixer. GSM850/EGSM900 and GSM1800 LNA's are connected directly to the pregain stages. The pregain stages as well as all the following receiver blocks are integrated in Helgo. The LNA's have three gain levels. The first one is the maximum gain, the second one is about 30 dB below the maximum, and the last one is the off state.

After the pregain stages there are demodulator mixers at each signal path to convert the RF signal directly down to baseband I and Q signals. Local oscillator signals for the mixers are generated by an external VCO. The frequency is divided by two in GSM1800 and GSM1900 and by four in GSM850/EGSM900. Those frequency dividers are integrated in Helgo and in addition to the division they also provide accurate phase shifting by 90 degrees which is needed for the demodulator mixers.

The demodulator output signals are all differential. After the demodulators there are amplifiers called DtoS (differential to single ended) which convert the differential signals to single ended. Before that, they combine the signals from the three demodulators to a single path which means that from the output of the demodulators to the baseband interface are just two signal paths (I and Q), which are common to all the frequency bands of operation. In addition, the DtoS amplifiers perform the first part of the channel filtering and AGC (automatic gain control). They have two gain stages, the first one with a constant gain of 12 dB and -3 dB bandwidth of 85 kHz and the second one with a switchable gain of $\pm$6 dB. The filters in the DtoS blocks are active RC filters. The rest of the analog channel filtering is provided by blocks called BIQUAD which include modified Sallen-Key biquad filters.

After the DtoS and BIQUAD blocks, there is another AGC-amplifier which provides a gain control range of 42 dB in 6 dB steps. The correlation between the gain steps and the absolute received power levels is found by a calibration routine in the production for each assembled phone.

In addition to the AGC steps, the last AGC stage also performs the real time DC offset compensation, which is needed in a direct conversion receiver to cancel out the effect of the local oscillator leakage. DC offset compensation is performed during an operation called DCN1. DCN1 is carried out by charging capacitors at the input of the last AGC stages to a voltage, which causes a zero DC offset. To improve the accuracy a DC level alignment possibility has been added to Helgo.

After the last AGC stages the single ended and filtered I- and Q-signals are fed to the RX

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ADCs. The maximum peak-to-peak voltage swing for the ADCs is 1.45 V.

General instructions for RX troubleshooting

Connect the phone to a PC with DAU-9S cable and dongle and follow the following instructions:

Measuring RX I/Q signals using RSSI

Start Phoenix Service Software and establish connection to the phone

Select	File -> Open Product
	RH-51, -52, -67 or -68
Select	Testing ->RF controls
Select	Band ->GSM850 / GSM900 / GSM1800 / GSM1900

Active unit ->RX

Operation mode ->Burst

RX/TX channel ->	EGSM900: 37
	GSM850: 190
	GSM1800: 700
	GSM1900: 661

Select

Testing	(T)
RSSI Reading	(R)

Set –up now looks like this:

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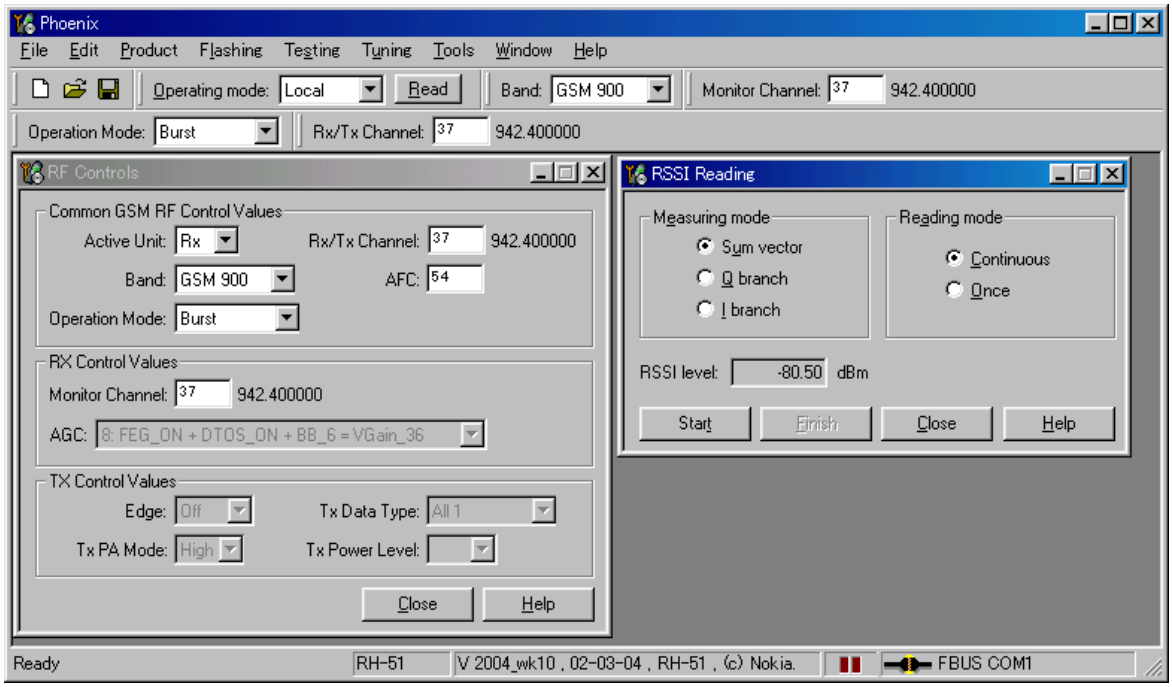

Apply a signal with frequency of

EGSM900:942.4677MHz (channel 37 + 67.7KHz offset)

GSM850: 881.667MHz (channel 190 + 67.7KHz offset)

GSM1800:1842.8677MHz (channel 700 + 67.7KHz offset)

GSM1900:1960.0677MHz (channel 661 + 67.7KHz offset)

and a power level of –80dBm to the RF connector (remember to compensate for cable loss).

In **RSSI reading,** click **Read now.**

The resulting RSSI level should be –80dBm in each band.

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Measuring RX performance using SNR measurement

Note: This measurements also provides an indication of the conducted sensitivity

Start Phoenix Service Software and establish connection to the phone

Select	File ->Open Product
	RH-51, -52, -67 or -68
Select	Testing ->RF controls
Select	Band ->GSM850 / GSM900 / GSM1800 / GSM1900
Active unit ->RX	
Operation mode ->Burst	
RX/TX channel ->	EGSM900: 37
	GSM850: 190
	GSM1800: 700
	GSM1900: 661

Select	Testing	(T)
	SNR Measurement	(M)
	select Both	

Choose respective band (GSM850, EGSM900, GSM1800, GSM1900).

Press Start.

Follow the instructions for Signal generator set–up in the pop–up window.

Press OK.

Read the SNR result. SNR should be: >18dB.

Check the sensitivity value.

The set–up should now look like this; the icon also includes pop–up window for reference:

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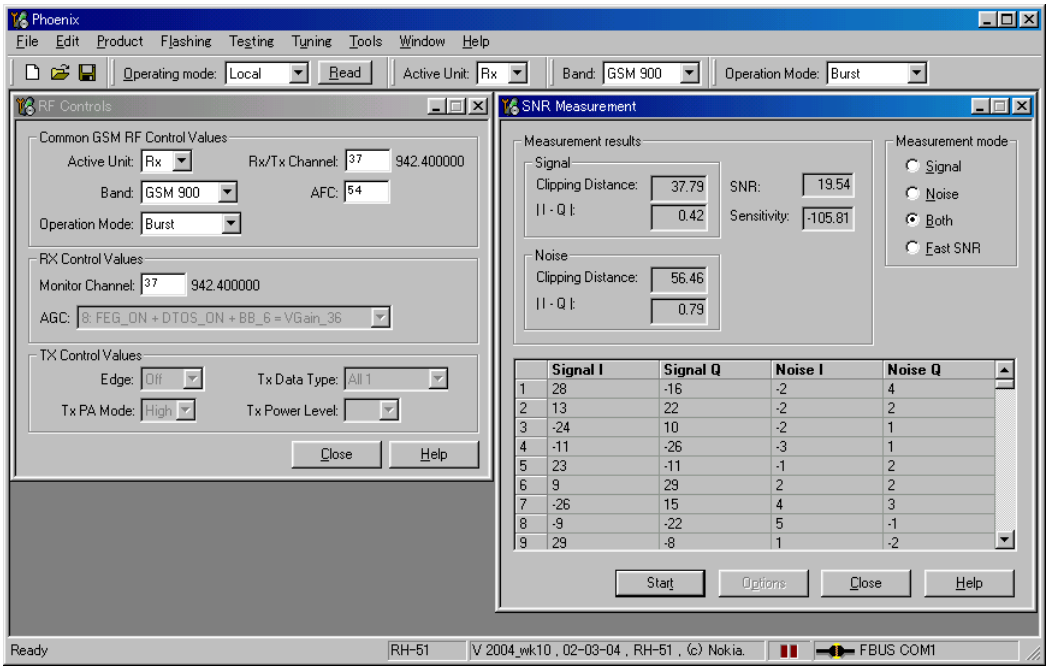
Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Operating mode: Local Read Active Unit: Rx Band: GSM 900 Operation Mode: Burst
RF Controls
Common GSM RF Control Values
Active Unit: Rx Rx/Tx Channel: 37 942.400000
Band: GSM 900 AFC: 54
Operation Mode: Burst
RX Control Values
Monitor Channel: 37 942.400000
AGC: 8: FEG_ON + DTOS_ON + BB_6 = VGain_36
TX Control Values
Edge: Off Tx Data Type: All 1
Tx PA Mode: High Tx Power Level:
Close Help
SNR Measurement
Measurement results
Signal
Clipping Distance: 37.79
I I - Q I: 0.42
SNR: 19.54
Sensitivity: -105.81
Noise
Clipping Distance: 56.46
I I - Q I: 0.79
Measurement mode
Signal
Noise
Both
Fast SNR
Signal I Signal Q Noise I Noise Q
1 28 -16 -2 4
2 13 22 -2 2
3 -24 10 -2 1
4 -11 -26 -3 1
5 23 -11 -1 2
6 9 29 2 2
7 -26 15 4 3
8 -9 -22 5 -1
9 29 -8 1 -2
Start Options Close Help
Ready
RH-51
V 2004_wk10 , 02-03-04 , RH-51 , (c) Nokia.
FBUS COM1

Measuring the RX module manually using oscilloscope and spectrum analyzer

Spectrum analyzer level values depend on the probe type and should be validated using a known good sample. The levels that are given here are measured using a high frequency probe.

Measuring with oscilloscope at test point RXI (J827) or RXQ (J828)) and RXID (J261) or RXQD (J262) is recommended only if RSSI reading does not provide enough information.

GSM 900/850

Start Phoenix Service Software and establish connection to the phone

Select	File Open Product
	RH-51, -52, -67 or -68
Select	Testing RF controls
Select	Band GSM900 (GSM850)
Active unit	RX
Operation mode	Continuous *
RX/TX channel	37 (190 for GSM850)
AGC	12

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Input freq/level of signal generator is 942.4677MHz, -60dBm

(881.6677MHz for GSM850)

Note: Because DC compensation doesn't work during continuous mode, DC offset level at RXI and RXQ will gradually shift from the optimized level. To have most reliable result, it is highly advisable to set operation mode from burst to continuous just before measuring values and complete measurement within no longer than 30 seconds.

Figure 4: Troubleshooting chart for EGSM900 (GSM850)

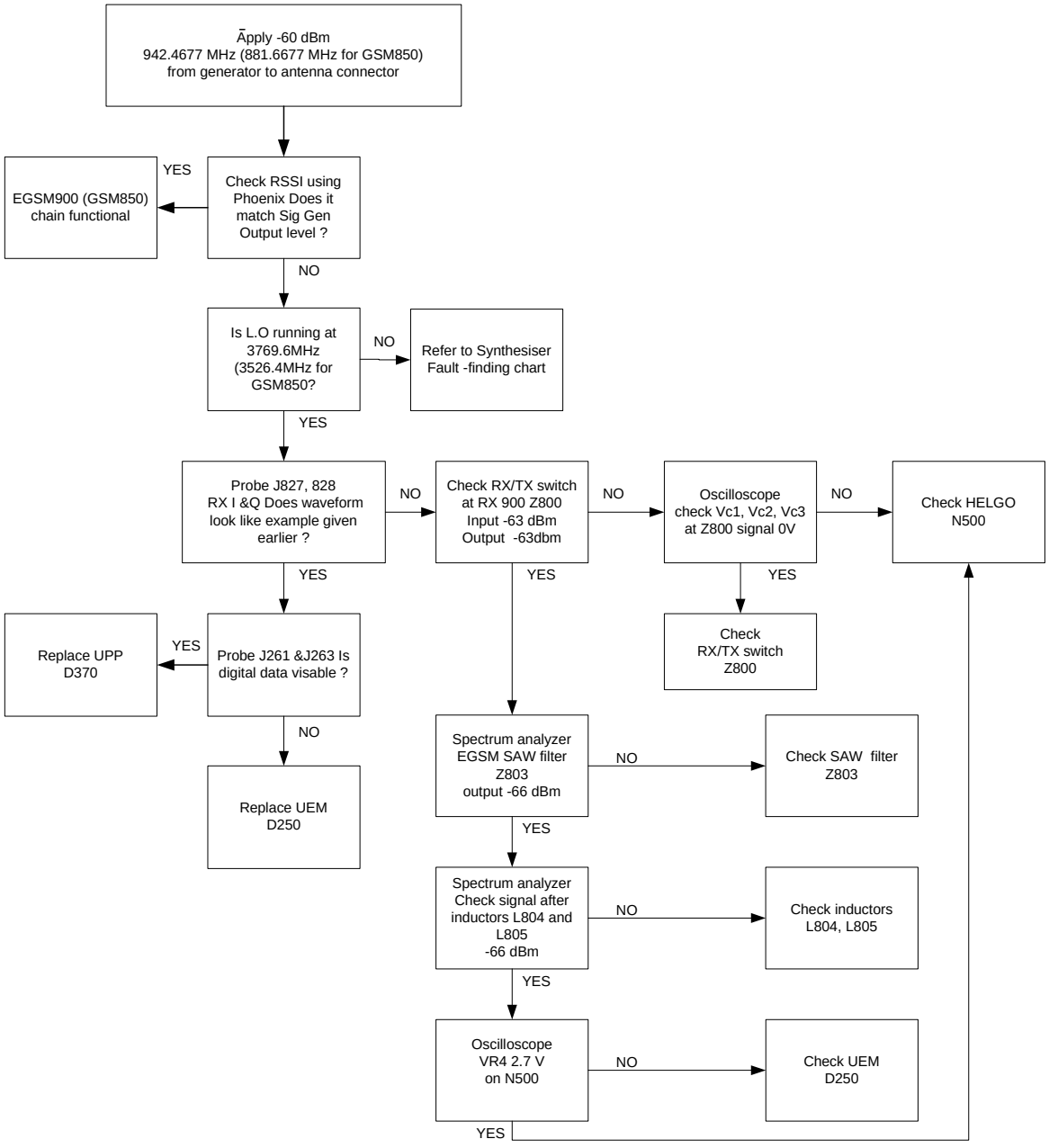
Āpply -60 dBm
942.4677 MHz (881.6677 MHz for GSM850)
from generator to antenna connector
Check RSSI using Phoenix Does it match Sig Gen Output level ?
YES
EGSM900 (GSM850) chain functional
NO
Is L.O running at 3769.6MHz (3526.4MHz for GSM850?
NO
Refer to Synthesiser Fault -finding chart
YES
Probe J827, 828 RX I &Q Does waveform look like example given earlier ?
NO
Check RX/TX switch at RX 900 Z800 Input -63 dBm Output -63dbm
NO
Oscilloscope check Vc1, Vc2, Vc3 at Z800 signal 0V
NO
Check HELGO N500
YES
YES
YES
Probe J261 &J263 Is digital data visable ?
YES
Replace UPP D370
NO
Replace UEM D250
Check RX/TX switch Z800
Spectrum analyzer EGSM SAW filter Z803 output -66 dBm
NO
Check SAW filter Z803
YES
Spectrum analyzer Check signal after inductors L804 and L805 -66 dBm
NO
Check inductors L804, L805
YES
Oscilloscope VR4 2.7 V on N500
NO
Check UEM D250
YES

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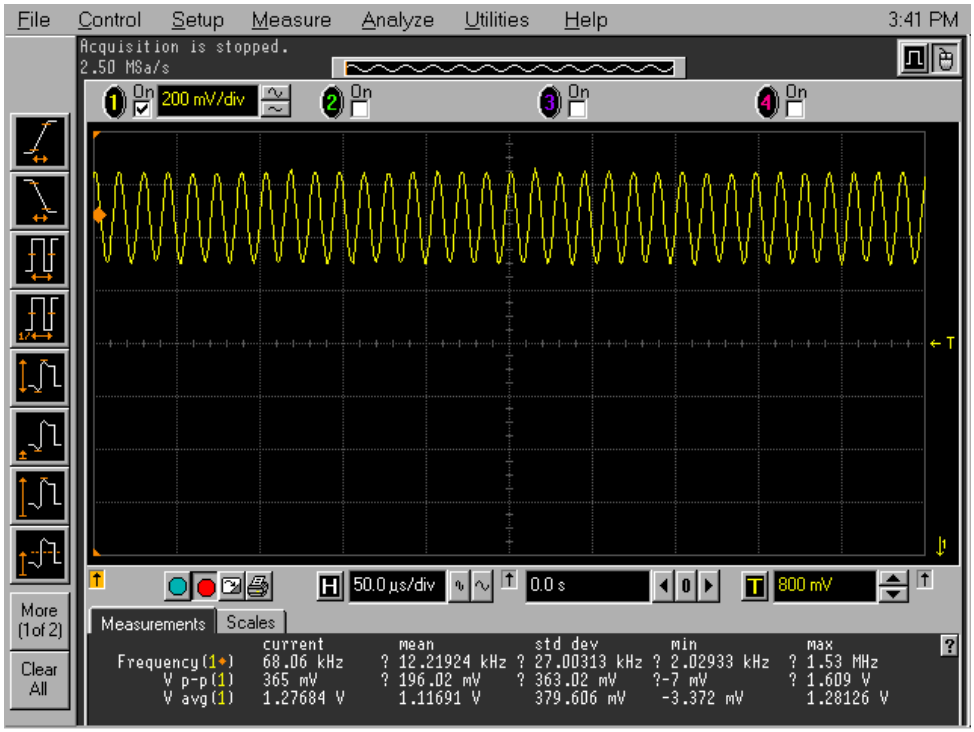
Figure 5: Probed RX I/Q signals J827, 828


File Control Setup Measure Analyze Utilities Help 3:41 PM
Acquisition is stopped.
2.50 MSa/s
200 mV/div
50.0 µs/div
0.0 s
800 mV
More (1 of 2)
Clear All
Measurements
Scales
current mean std dev min max
Frequency(1) 68.06 kHz ? 12.21924 kHz ? 27.00313 kHz ? 2.02933 kHz ? 1.53 MHz
V p-p(1) 365 mV ? 196.02 mV ? 363.02 mV ?-7 mV ? 1.609 V
V avg(1) 1.27684 V 1.11691 V 379.606 mV -3.372 mV 1.28126 V

Signal amplitude	180 ~ 600mVpp
DC offset	1.2 ~ 1.4V
Frequency	approx 67KHz

GSM1800

Start Phoenix Service Software and establish connection to the phone.

Select	File Open Product
	RH-51, -52, -67 or 68
Select	Testing RF controls
Select	Band GSM1800
Active unit	RX
Operation mode	Continuous *
RX/TX channel	700
AGC	12

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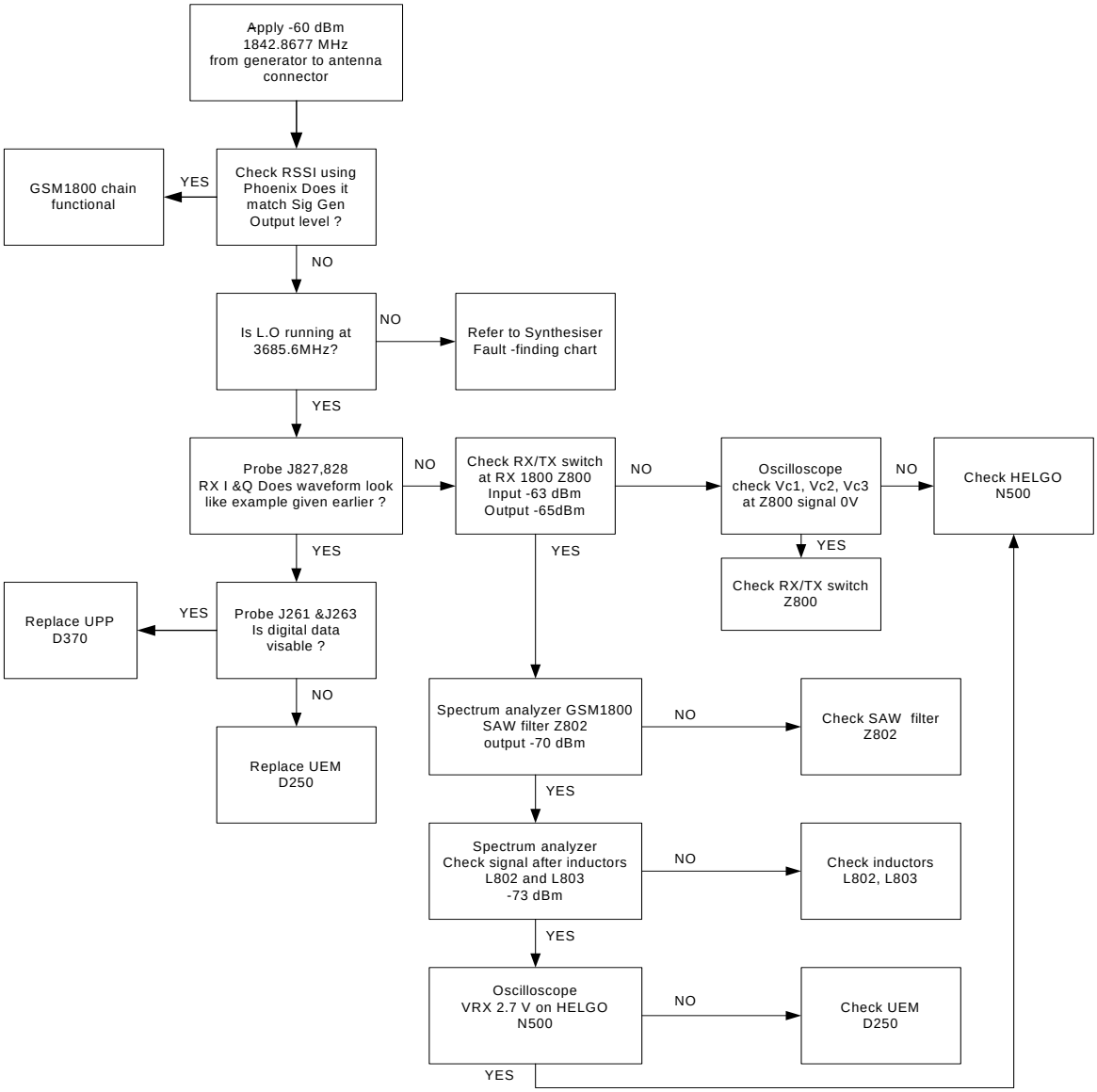
Input freq/level of signal generator is 1842.8677MHz, -60dBm

Note: Because DC compensation doesn't work during continuous mode, DC offset level at RXI and RXQ will gradually shift from the optimized level. To have most reliable result, it is highly advisable to set operation mode from burst to continuous just before measuring values and complete measurement within no longer than 30 seconds.

Figure 6: Troubleshooting chart for GSM1800



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GSM1900

Start Phoenix Service Software and establish connection to the phone.

Select	File	Open Product
	RH-51, -52, -67 or -68	
Select	Testing	RF controls
Select	Band	GSM1900
Active unit		RX
Operation mode	Continuous *	
RX/TX channel	661	
AGC	12	

Input freq/level of signal generator is 1960.0677MHz, -60dBm

Note: Because DC compensation doesn't work during continuous mode, DC offset level at RXI and RXQ will gradually shift from the optimized level. To have most reliable result, it is highly advisable to set operation mode from burst to continuous just before measuring values and complete measurement within no longer than 30 seconds.

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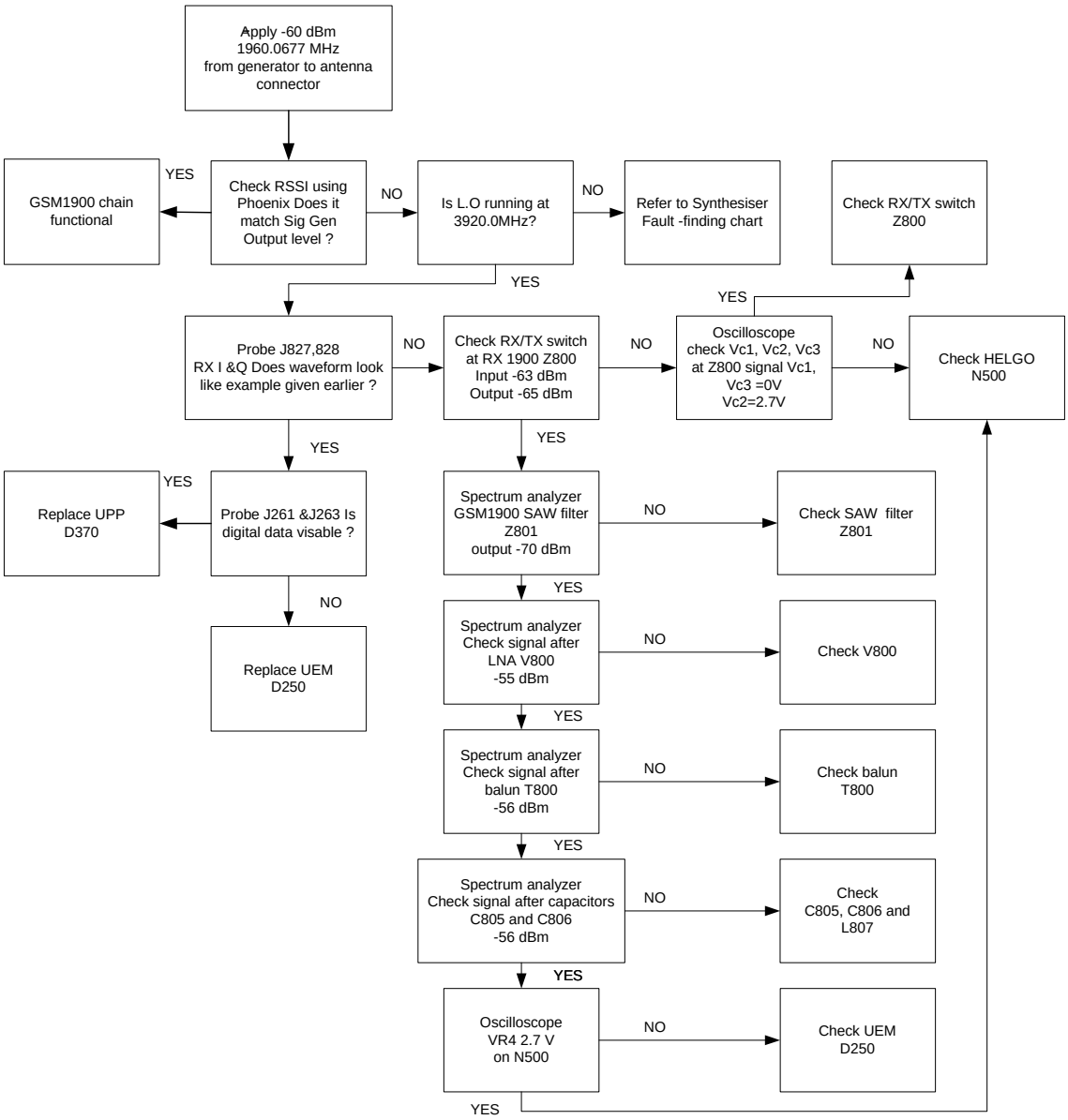
Figure 7: Troubleshooting chart for GSM1900



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Measurement points in the receiver

Figure 8: Measurement points at RX frontend - part 1

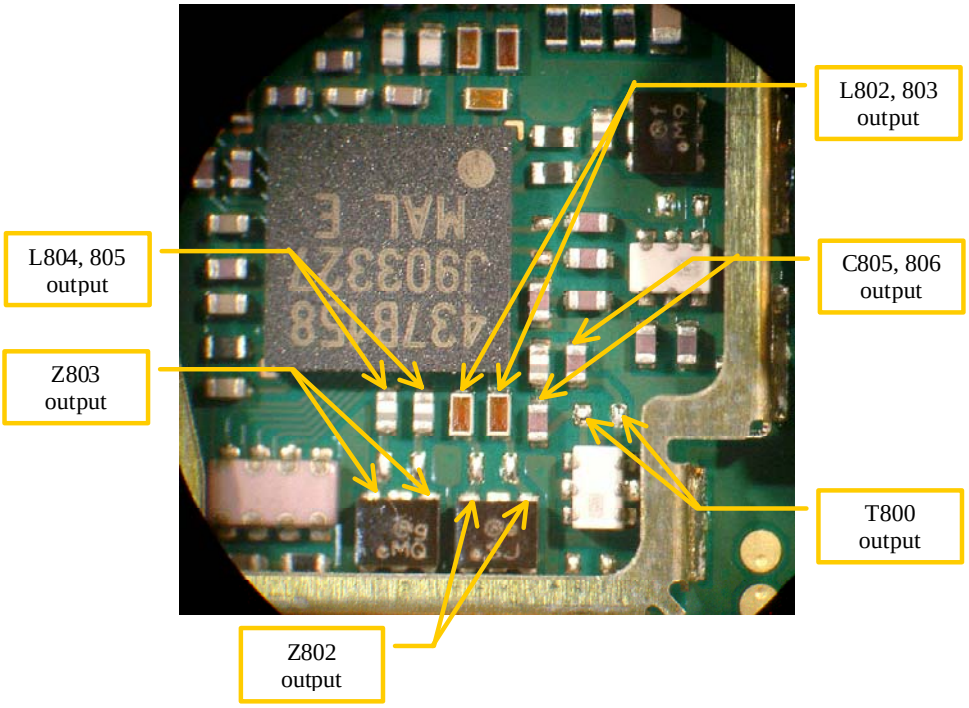

Figure 9: Measurement points at RX frontend - part 2

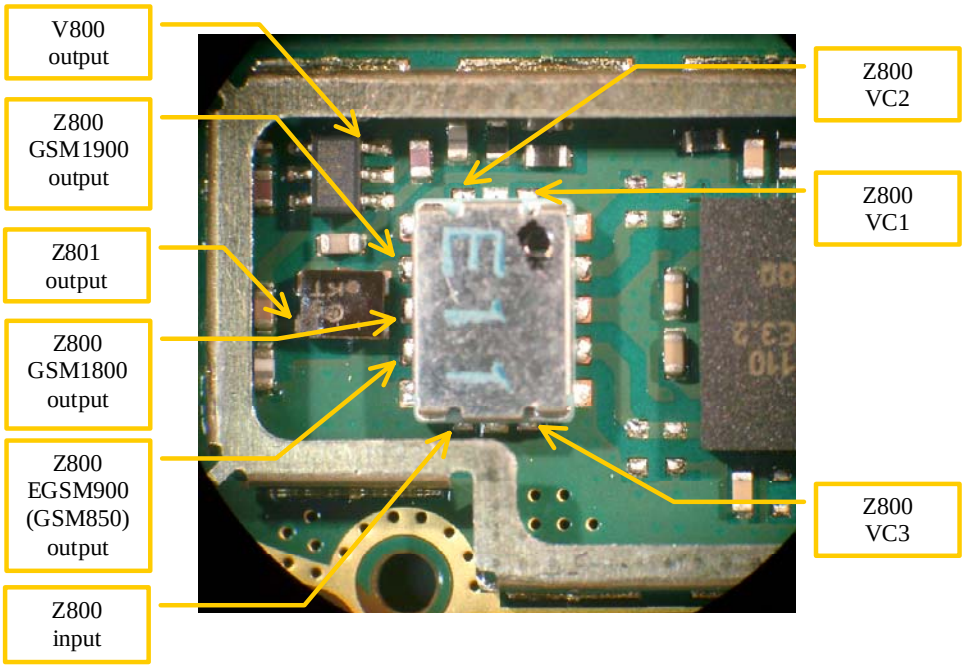

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Figure 10: Measurement points at baseband IQ

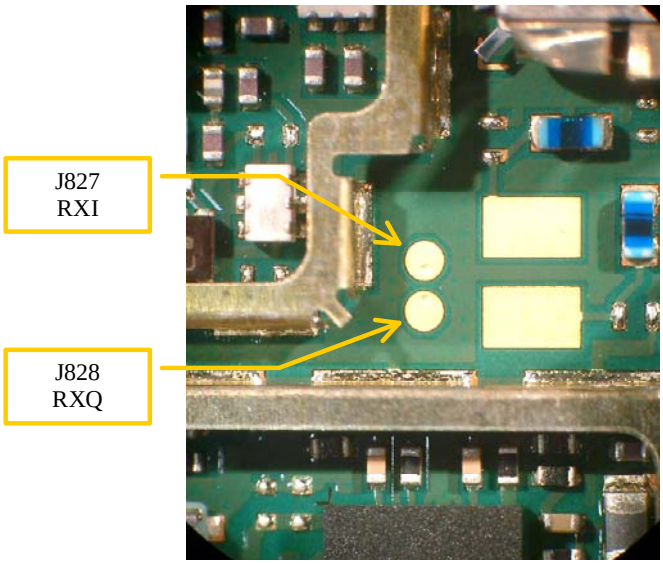
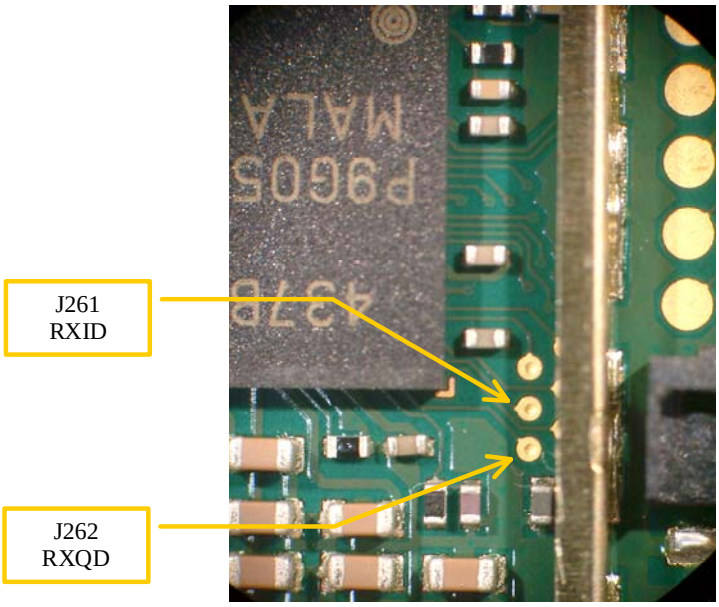


Figure 11: Measurement points at digital IQ



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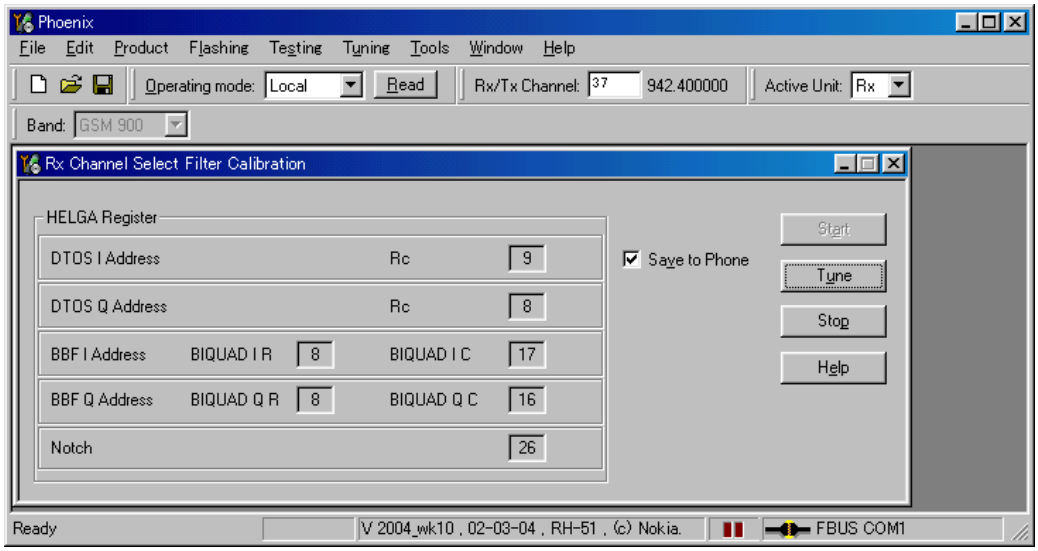
Tuning RX using Phoenix

RX channel select filter calibration

This calibration calibrates the baseband filter inside Helgo ASIC. It is done by internally measuring a prototype filter, for this reason the calibration is done once, not separately 3 bands.

This tuning doesn't require RF input from an external signal generator.

Select Tuning RX Channel Select Filter Calibration



Check "Save to Phone"

Press Tune

Press Stop to store the data to the phone.

RX channel select filter calibration is finished.

RX calibration

The "RX calibration" is used to determine gain at different gain settings for front-end and the Helgo ASIC and needs to be done in all three bands.

RX calibration requires an external signal generator.

Select Tuning RX calibration

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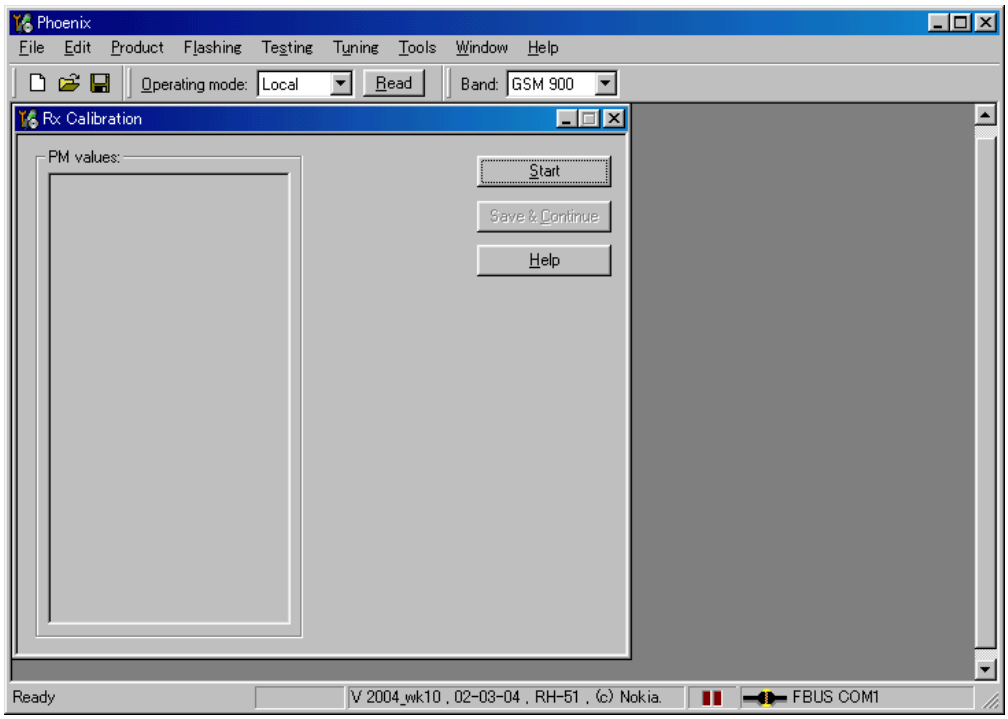

Check Automatic calibration mode.

Check load from phone and Save to phone.

Press Start

Initial data will be loaded from the phone and calibration starts.

You will see following banner pops up.

Tuning step 1 of 3 - Rx Calibration with band EGSM900
Set the Rf signal generator:
Power level:
-60 dBm
Input signal frequency:
942.467710 MHz
Press OK to tune, press Cancel or ESC to exit tuning process.
OK
キャンセル

Follow the instructions in the pop–up window and set frequency and level of the signal generator

Press OK

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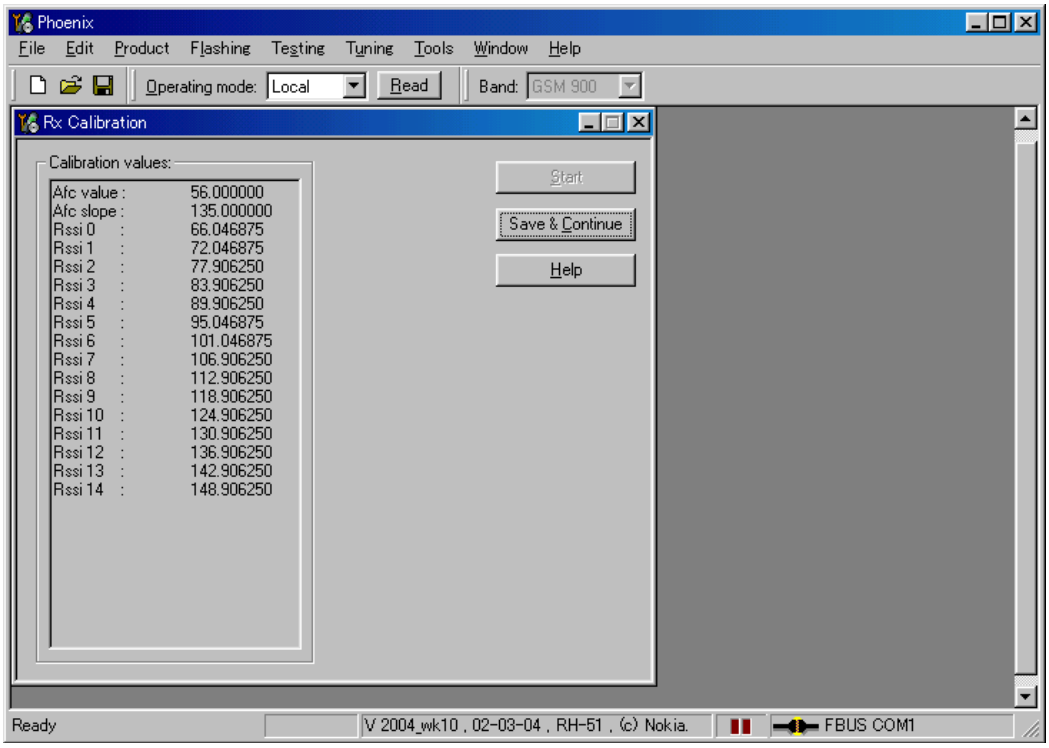

Press "Save & Continue"

Calibration data will be stored to the phone and continue to the next band.

RX band filter response compensation

Rx band filter response compensation has 9 steps for each band.

Rx band filter response compensation requires an external signal generator.

Select Tuning RX Band Filter Response Compensation

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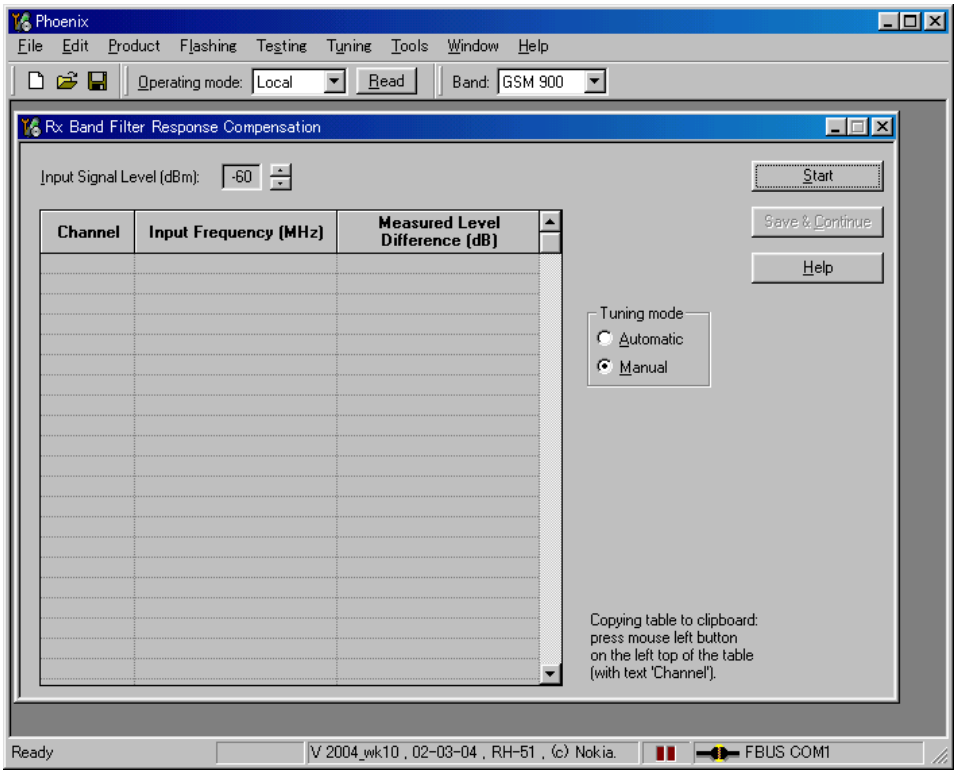
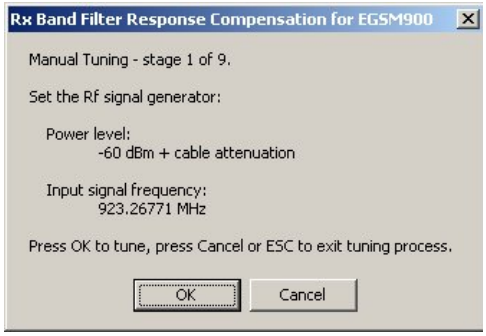


Select Manual Tuning mode

Press Start.

Initial data will be loaded from the phone.

Press tune to start calibration.


Rx Band Filter Response Compensation for EGSM900
Manual Tuning - stage 1 of 9.
Set the Rf signal generator:
Power level:
-60 dBm + cable attenuation
Input signal frequency:
923.26771 MHz
Press OK to tune, press Cancel or ESC to exit tuning process.
OK
Cancel

Follow the instructions given in the following pop–up window and set frequency and level of the signal generator.

Press OK to proceed to the next step.

After completely the 9 steps –calibration at 9 frequencies.

Test will be repeated for other bands.

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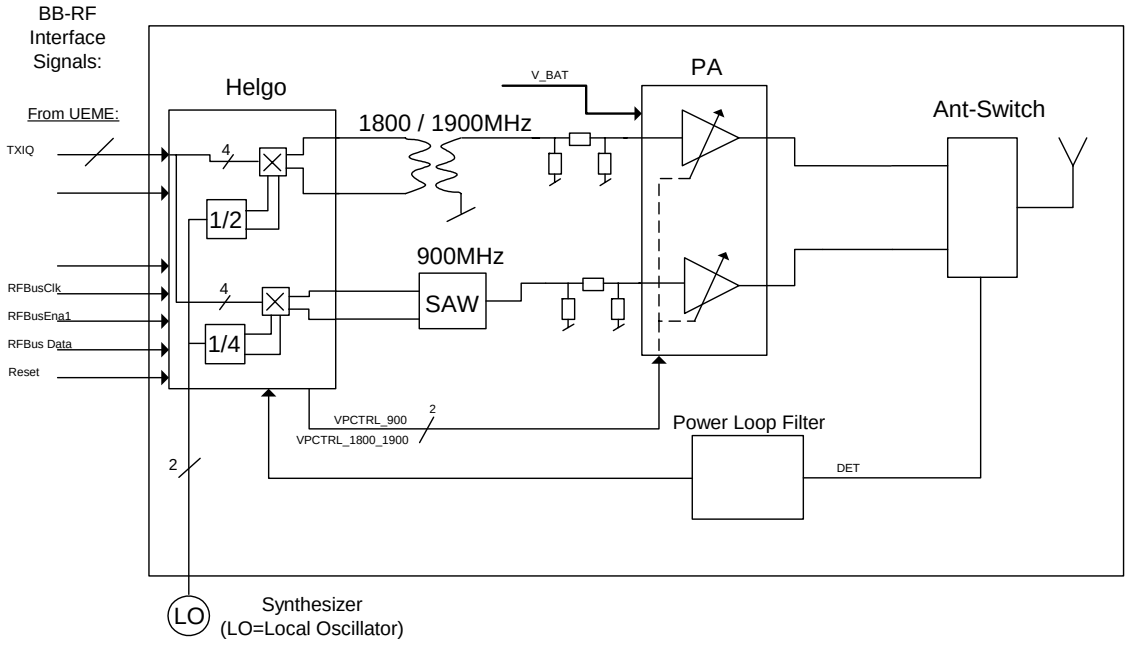
Transmitter troubleshooting

General description

A simple block diagram of the TX part of the phone is shown in the following figure. The voice or data signals to be transmitted come from the UEME IC in the BB (baseband) area, and go to the Helgo IC, where they are up-converted to RF. The TX signals going from UEME to Helgo are called the IQ-signals, and consist of two balanced signals { TXIN, TXIP } and { TXQN, TXQP }, i.e. a total of four signal lines. In addition to the IQ signals, there are also control signals going between BB and RF.

Figure 12: TX RF block diagram



The following picture shows the two shielding cans where the TX circuitry is located (the lids have been removed). The upper shielding can contains BB-RF interface circuitry, the Helgo RF system IC, a SAW filter for the GSM/EGSM band, and a balun for the DCS/PCS band. The lower shielding can contains the power amplifier (PA) and the antenna switch module (ASM).

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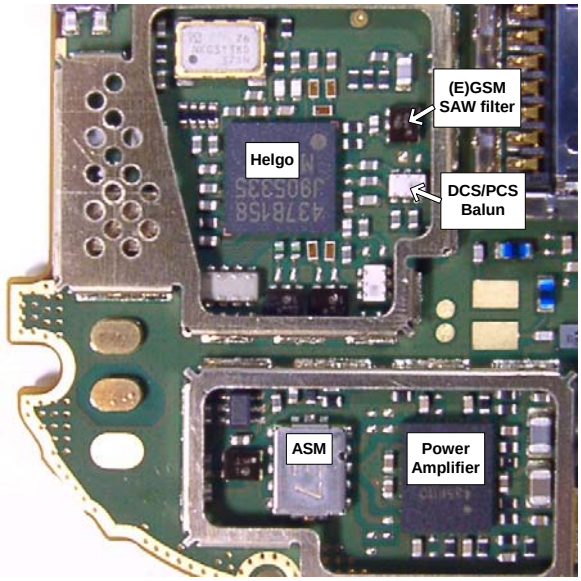

hh

Preparation for troubleshooting

- Place the phone (mechanics removed) on module jig.
- Connect the module jig to the PC via a DAU-9P cable.
- Connect the module jig to a power supply (4.2V).
- Connect the RF output to a spectrum analyzer or another measurement instrument. Use a 10dB attenuator at the input to spectrum analyzer to avoid damaging it.
- Make sure the dongle is connected and start Phoenix.
- In Phoenix: File → Open Product → **RH-51, -52, -67 or -68** Product Menu.
- Select Testing → RF Controls.
- From the toolbar: set Operating Mode to Local.
- Select band 'GSM850' 'GSM900', 'GSM1800' or 'GSM1900'.
- Set Operation Mode to Burst.
- Set Active Unit to Tx.
- Set Tx Data Type to All 1.
- Set Rx/Tx Channel to 190 for GSM850, 37 for GSM900, 700 for GSM1800 or 661 for GSM1900.
- Set Tx PA Mode to Free.
- Set Tx Power Level to 5 in GSM850/GSM900, otherwise to 0.

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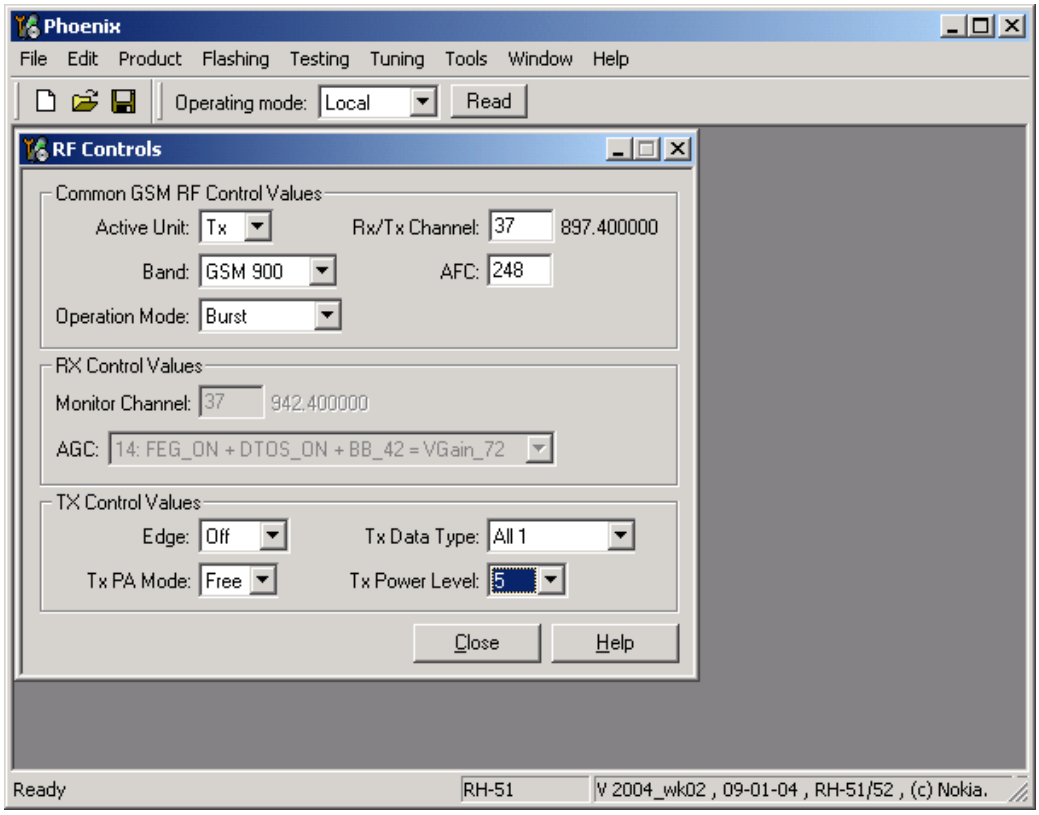
Phoenix should now look like this:



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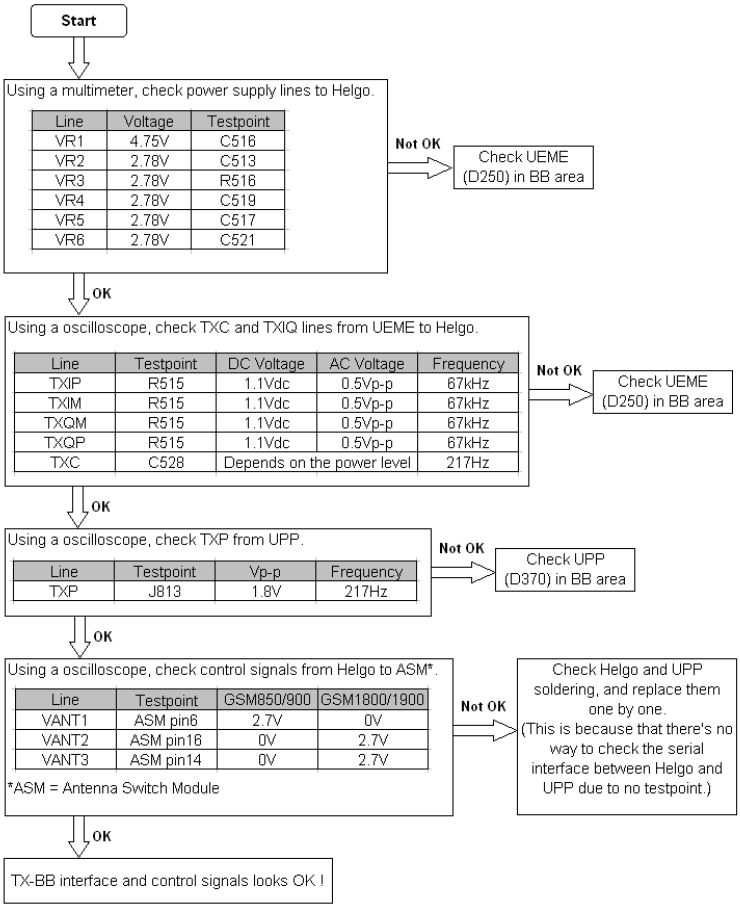
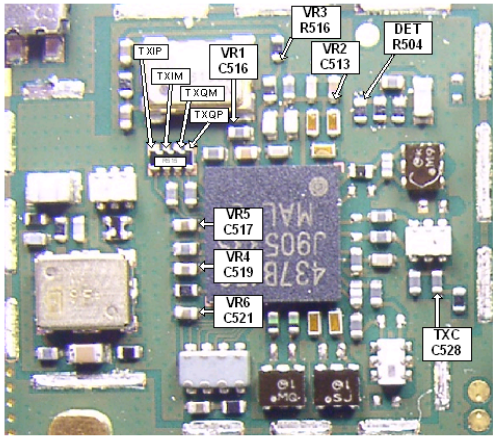
Fault-finding chart: TX-BB interface and control signals

Figure 13: Troubleshooting chart of TX-BB interface and control signals


Start
Using a multimeter, check power supply lines to Helgo.
Line | Voltage | Testpoint
VR1 | 4.75V | C516
VR2 | 2.78V | C513
VR3 | 2.78V | R516
VR4 | 2.78V | C519
VR5 | 2.78V | C517
VR6 | 2.78V | C521
Not OK
Check UEME (D250) in BB area
OK
Using a oscilloscope, check TXC and TXIQ lines from UEME to Helgo.
Line | Testpoint | DC Voltage | AC Voltage | Frequency
TXIP | R515 | 1.1Vdc | 0.5Vp-p | 67kHz
TXIM | R515 | 1.1Vdc | 0.5Vp-p | 67kHz
TXQM | R515 | 1.1Vdc | 0.5Vp-p | 67kHz
TXQP | R515 | 1.1Vdc | 0.5Vp-p | 67kHz
TXC | C528 | Depends on the power level | | 217Hz
Not OK
Check UEME (D250) in BB area
OK
Using a oscilloscope, check TXP from UPP.
Line | Testpoint | Vp-p | Frequency
TXP | J813 | 1.8V | 217Hz
Not OK
Check UPP (D370) in BB area
OK
Using a oscilloscope, check control signals from Helgo to ASM*.
Line | Testpoint | GSM850/900 | GSM1800/1900
VANT1 | ASM pin6 | 2.7V | 0V
VANT2 | ASM pin16 | 0V | 2.7V
VANT3 | ASM pin14 | 0V | 2.7V
*ASM = Antenna Switch Module
Not OK
Check Helgo and UPP soldering, and replace them one by one. (This is because that there's no way to check the serial interface between Helgo and UPP due to no testpoint.)
OK
TX-BB interface and control signals looks OK !



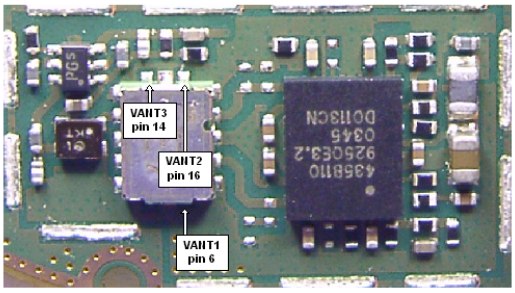
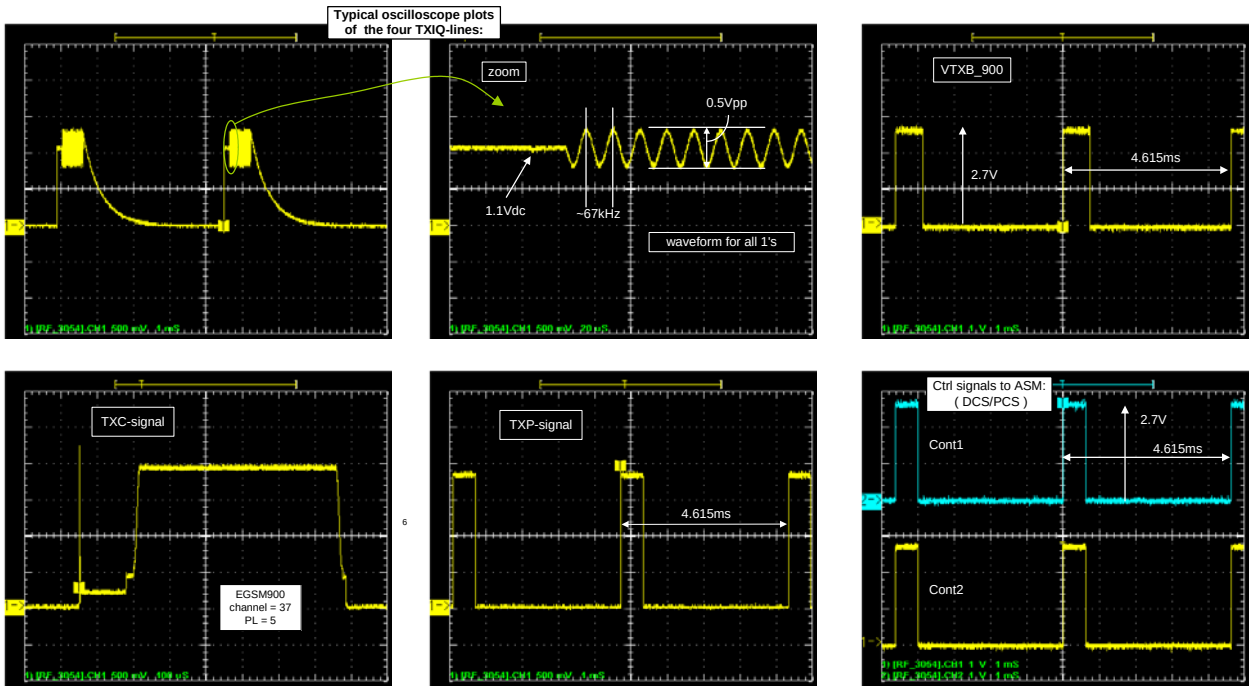


Figure 14: Oscilloscope screen shots



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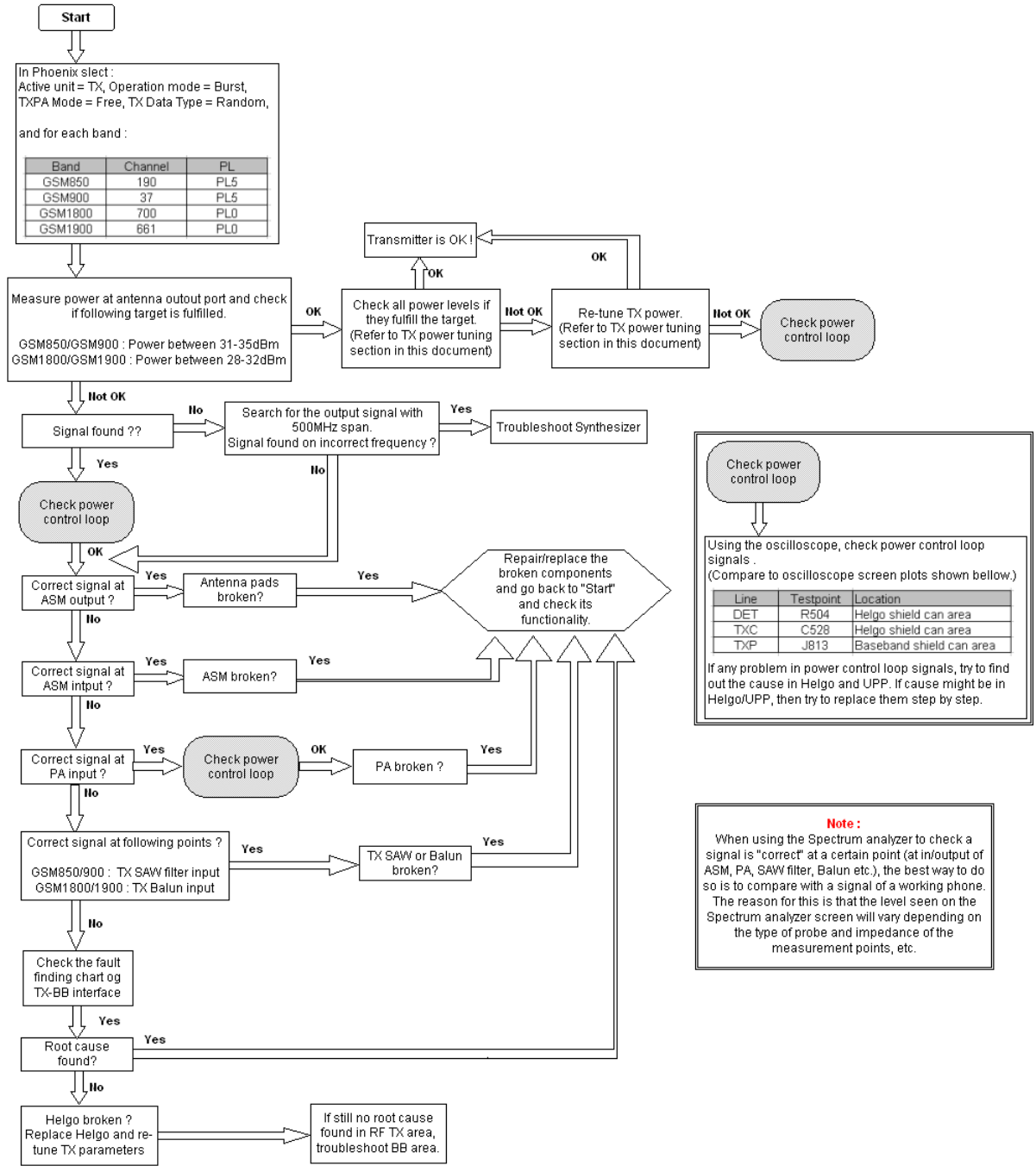
Fault-finding chart: RF side of transmitter

Figure 15: Troubleshooting chart of RF side of transmitter


Start
In Phoenix slect :
Active unit = TX, Operation mode = Burst,
TXPA Mode = Free, TX Data Type = Random,
and for each band :
Band | Channel | PL
GSM850 | 190 | PL5
GSM900 | 37 | PL5
GSM1800 | 700 | PL0
GSM1900 | 661 | PL0
Measure power at antenna outout port and check if following target is fulfilled.
GSM850/GSM900 : Power between 31-35dBm
GSM1800/GSM1900 : Power between 28-32dBm
OK
Check all power levels if they fulfill the target. (Refer to TX power tuning section in this document)
Not OK
Re-tune TX power. (Refer to TX power tuning section in this document)
Not OK
Check power control loop
OK
Transmitter is OK !
OK
Not OK
Signal found ??
No
Search for the output signal with 500MHz span. Signal found on incorrect frequency ?
Yes
Troubleshoot Synthesizer
Yes
Check power control loop
No
OK
Correct signal at ASM output ?
Yes
Antenna pads broken?
Yes
Repair/replace the broken components and go back to "Start" and check its functionality.
No
Correct signal at ASM intput ?
Yes
ASM broken?
Yes
No
Correct signal at PA input ?
Yes
Check power control loop
OK
PA broken ?
Yes
No
Correct signal at following points ?
GSM850/900 : TX SAW filter input
GSM1800/1900 : TX Balun input
Yes
TX SAW or Balun broken?
Yes
No
Check the fault finding chart og TX-BB interface
Yes
Root cause found?
Yes
No
Helgo broken ? Replace Helgo and re-tune TX parameters
If still no root cause found in RF TX area, troubleshoot BB area.
Check power control loop
Using the oscilloscope, check power control loop signals .
(Compare to oscilloscope screen plots shown bellow.)
Line | Testpoint | Location
DET | R504 | Helgo shield can area
TXC | C528 | Helgo shield can area
TXP | J813 | Baseband shield can area
If any problem in power control loop signals, try to find out the cause in Helgo and UPP. If cause might be in Helgo/UPP, then try to replace them step by step.
Note :
When using the Spectrum analyzer to check a signal is "correct" at a certain point (at in/output of ASM, PA, SAW filter, Balun etc.), the best way to do so is to compare with a signal of a working phone. The reason for this is that the level seen on the Spectrum analyzer screen will vary depending on the type of probe and impedance of the measurement points, etc.

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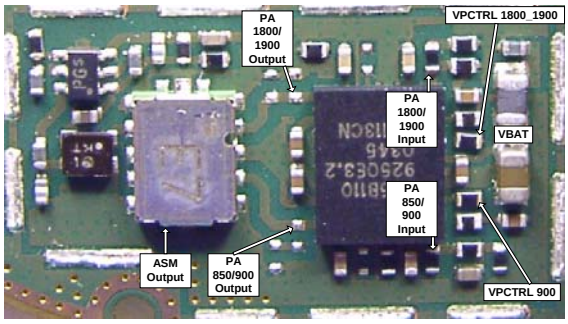

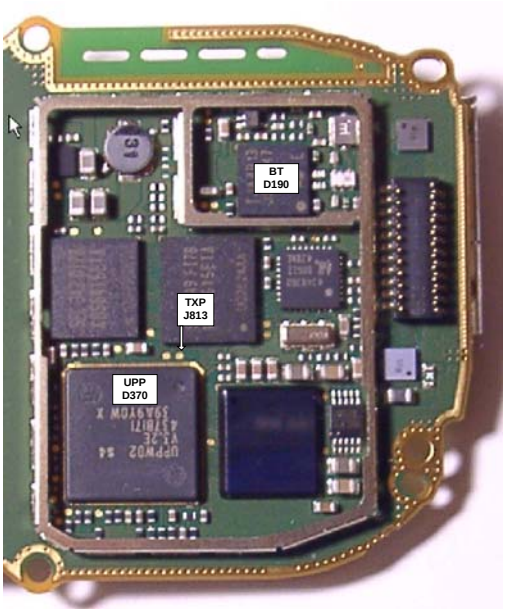

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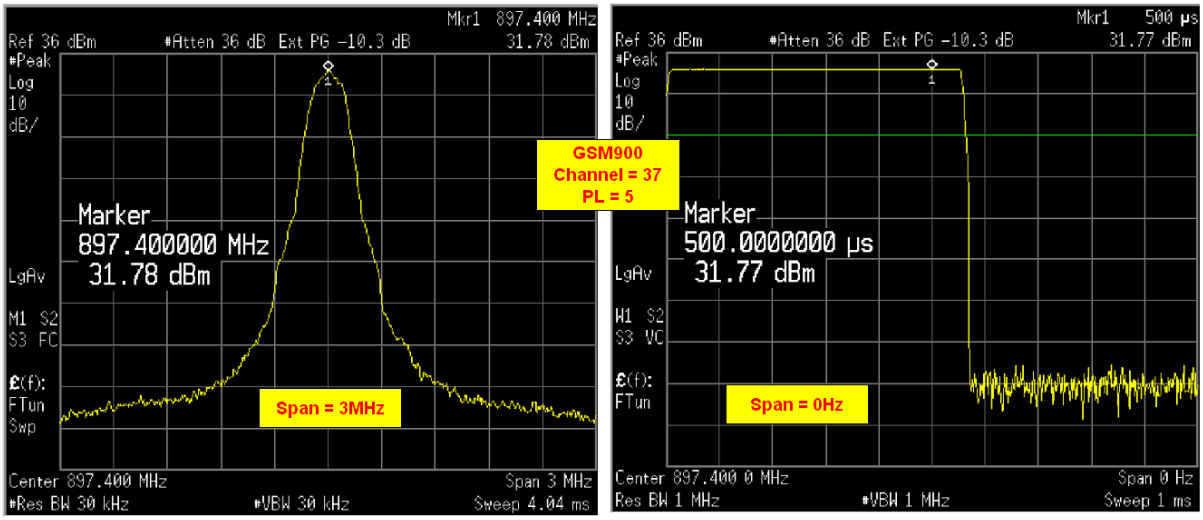
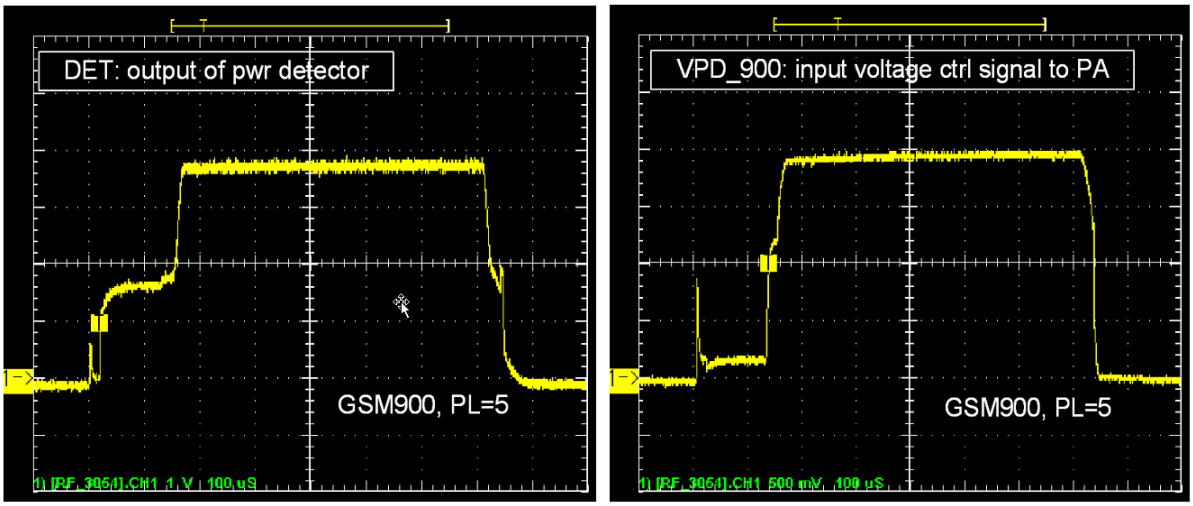
<< Spectrum analyzer screenshots >>
Measurements done at RF connector



<< Oscilloscope screen plots >>



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Transmitter tuning

In the transmitter there are two kinds of tunings that can be done; IQ tuning and power level tuning. In general, different repairs require different tunings. In order to decide which tuning is necessary after a repair, it is important to understand well the functionality of the repaired circuit. In general, it is recommended that if any TX component is changed, both these tunings be done. *All tunings are done in local mode, and using Phoenix to control the phone.*

In addition to that, note that the product has two different variants; RH-51, -67 (GSM900/GSM1800/GSM1900) and RH-52, -68 (GSM850/GSM1800/GSM1900), and please proceed the tuning with corresponding bands for those variants. In this document, some examples are described using GSM900 case, however please replace its description as GSM850 if you handle the RH-52, -68 variant.

Also, as the RH-51/52, RH-67/68 doesn't support EDGE feature, you don't need to consider operating / tuning the phones in EDGE mode although Phoenix sometimes has a control selectional box to enable EDGE.

TX IQ tuning

The tuning must be carried out in all three bands. In addition to Phoenix, a spectrum analyzer (SA) is needed. Connect the SA to the RF connector of the module jig. The settings of the spectrum analyzer will depend on the band to be tuned. The following table summarizes the settings for each of the three bands.

Table 1: Spectrum analyzer settings

	GSM850	GSM900	GSM1800	GSM1900
Center frequency	836.6MHz	897.4MHz	1747.8MHz	1880MHz
Frequency span	300kHz	300kHz	300kHz	300kHz
Resolution Bandwidth	3kHz	3kHz	3kHz	3kHz
Video Bandwidth	3kHz	3kHz	3kHz	3kHz
Sweep Time	3 sec	3 sec	3 sec	3 sec
Trace Type	Clear/Write	Clear/Write	Clear/Write	Clear/Write
Detector Type	Max Peak	Max Peak	Max Peak	Max Peak
Reference Level	35dBm	35dBm	35dBm	35dBm
Marker 1	836.53229 MHz	897.33229 MHz	1747.73229 MHz	1879.93229 MHz
Marker 2	836.6 MHz	897.4MHz	1747.8MHz	1880MHz
Marker 3	836.66771 MHz	897.46771MHz	1747.86771MHz	1880.06771MHz

For this tuning, two windows of Phoenix must be open: (1) Testing → RF Controls, and (2) Tuning → TX IQ Tuning, as seen in figures below.

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Figure 16: Phoenix set-up (RF Controls menu)

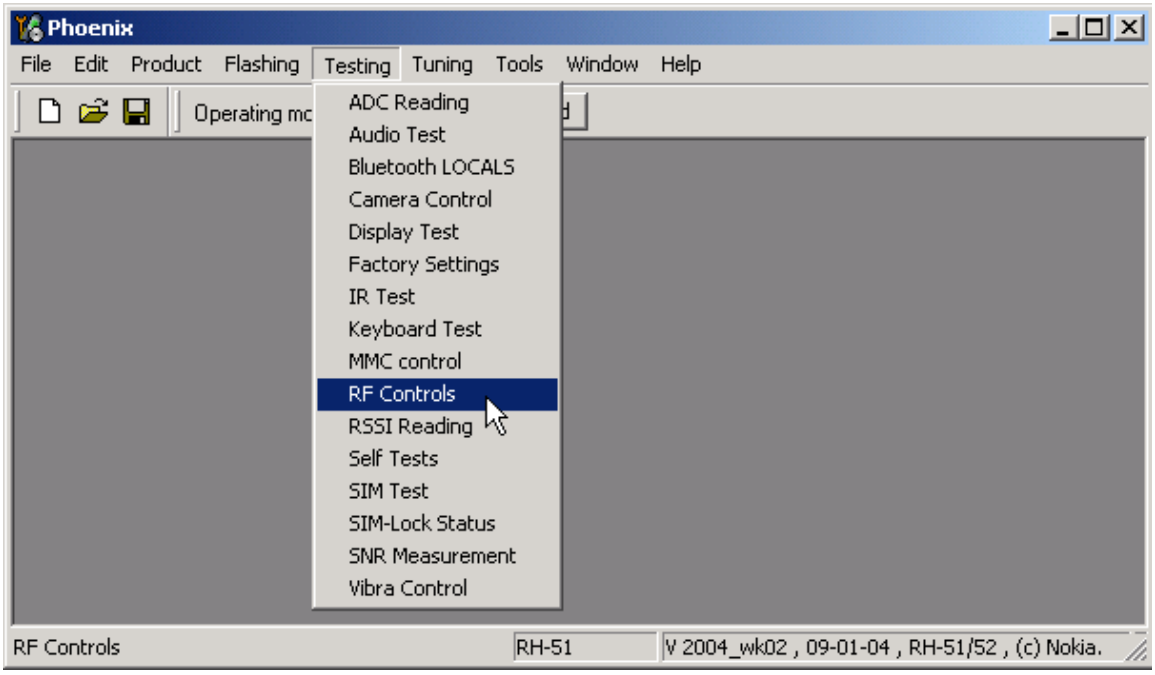
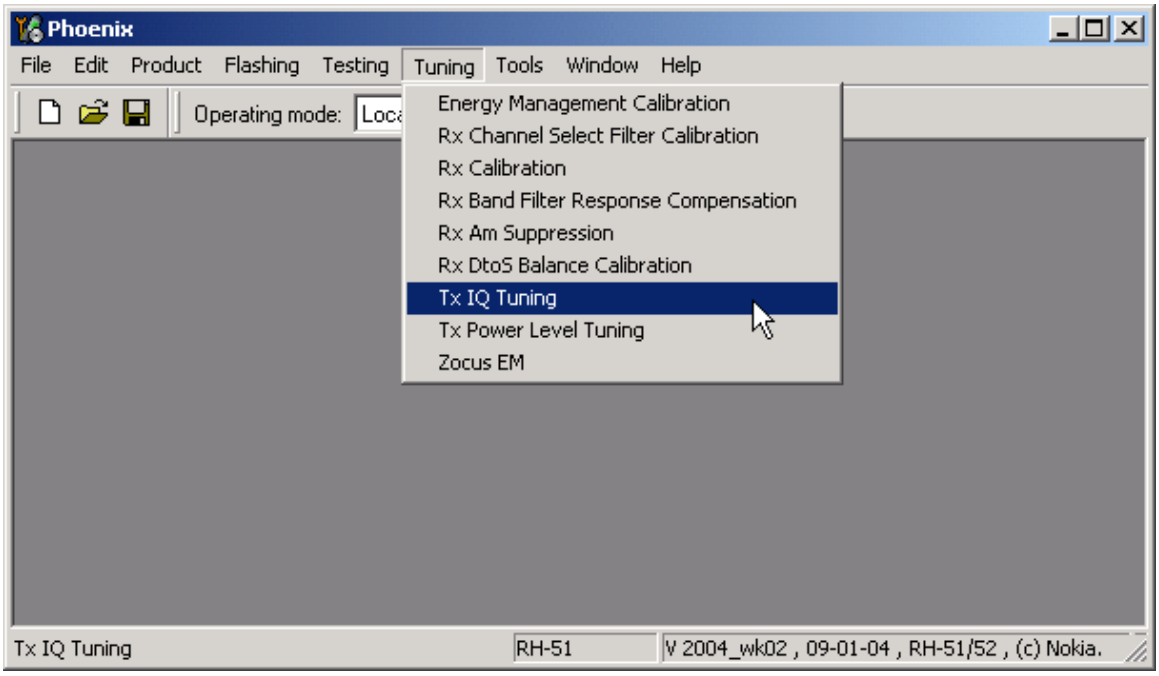


Figure 17: Phoenix set-up (Tx IQ Tuning menu)



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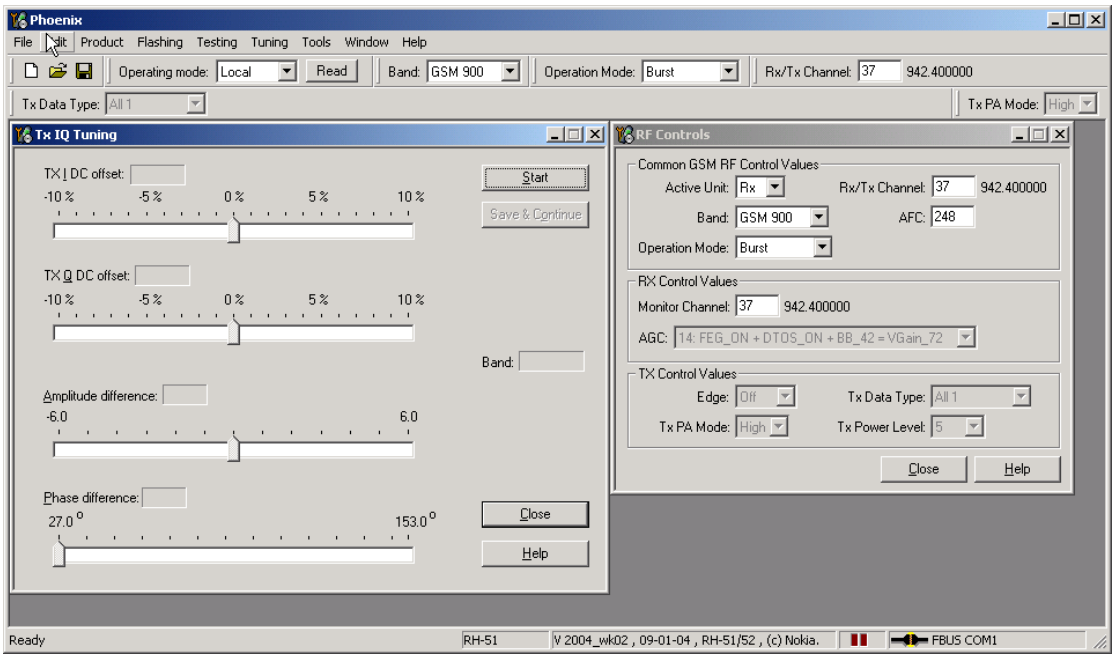
After opening the two before-mentioned windows, Phoenix should look like this:

Figure 18: Phoenix set-up (Tx IQ Tuning windows)



The following table summarizes the settings of the RF control window for IQ tuning of the three bands.

Table 2: RF Control window settings

Band	TX Data Type	TX Power Level	RX/TX Channel
GSM850	All 1	5	190
GSM900	All 1	5	37
GSM1800	All 1	0	700
GSM1900	All 1	0	661

To start the IQ tuning, press the 'Start' button in the IQ tuning window.

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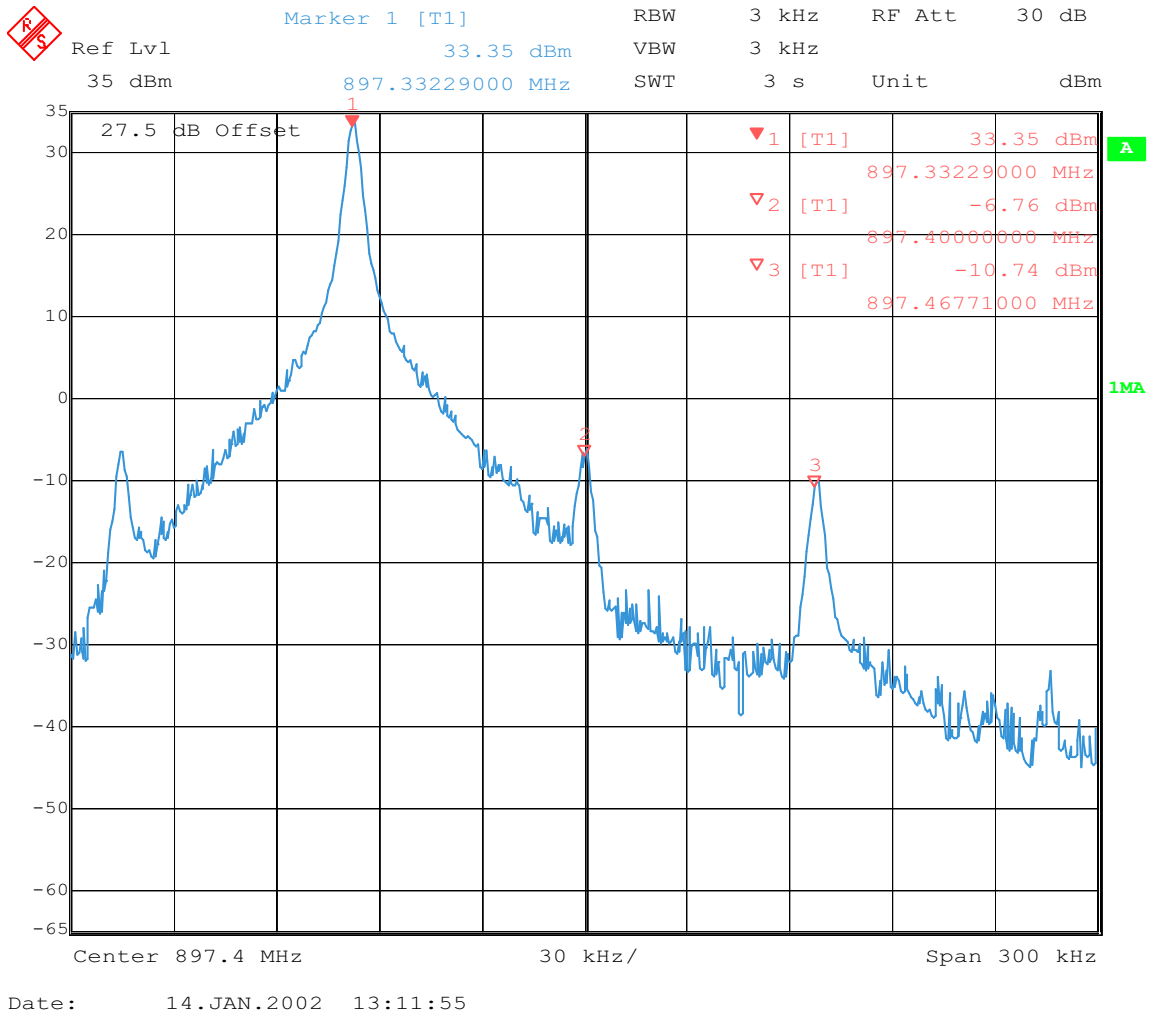
Figure 19: Spectrum analyzer screen shot when performing IQ tuning, part 1



The purpose of this tuning is to reduce the frequency components at marker 2 (carrier leakage) and marker 3 (+67kHz / upper sideband) as much as possible. Adjust the 'TXI DC Offset' and the 'TXQ DC Offset' buttons in the TX IQ Tuning window so that the carrier level (marker 2) reaches a minimum. After this adjustment is done, the carrier (marker 2) should be at least 40dB below the lower side band (marker 1).

Next, use the 'Amplitude difference' and the 'Phase difference' buttons in the TX IQ Tuning window to adjust the upper side band (marker 3) to a minimum. Now, marker 3 should also be at least 40dB below marker 1.

At this point, the spectrum analyzer screen should look similar to that of the figure below.

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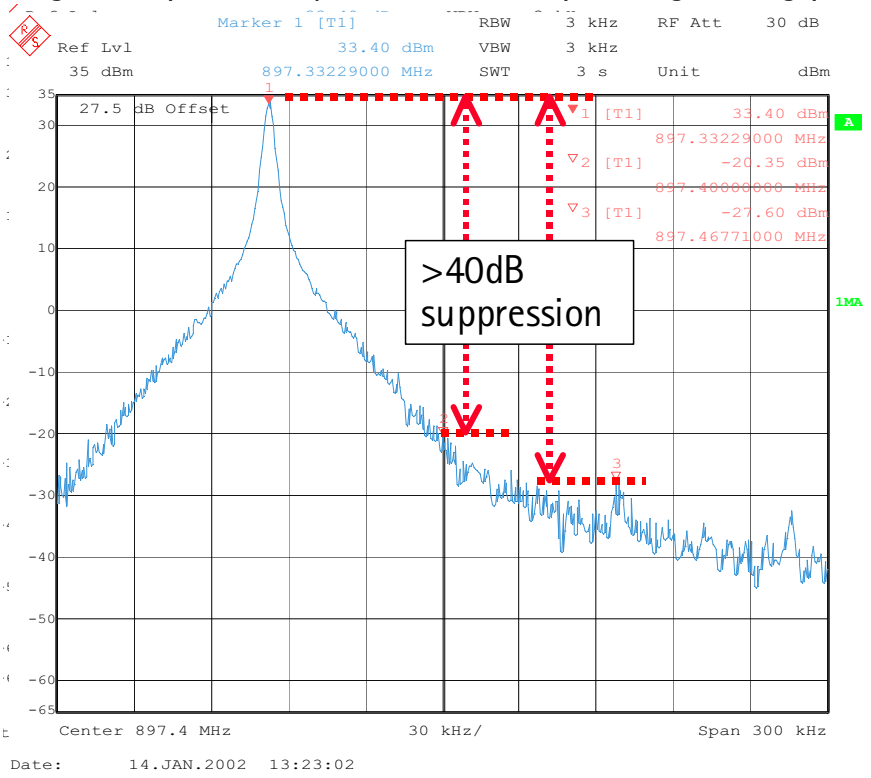
Figure 20: Spectrum analyzer screen shot when performing IQ tuning, part 2



After reducing the amplitude of the frequency components at marker 2 and 3 to a minimum, press 'Save & Continue'. The EGSM tuning has now been completed.

Now, using the spectrum analyzer settings listed in Table "Spectrum analyzer settings" and the RF control settings listed in Table "RF Control window settings", follow exactly the same procedure to perform IQ tuning in the GSM1800 and GSM1900 bands.

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TX power level tuning

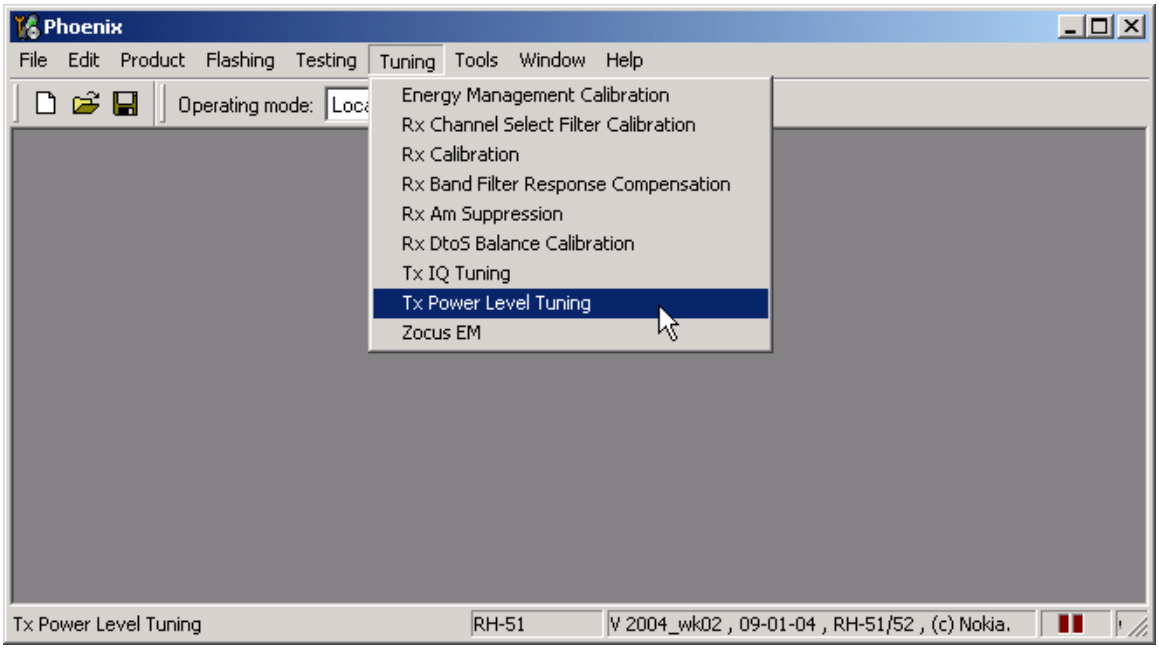
This tuning is done separately in all three bands, and requires a spectrum analyzer to measure the burst power of the GSM RF signal. When measuring the RF output (burst) power on a spectrum analyzer, use the settings found in the following table:

Table 3: Spectrum analyzer settings for Tx power level tuning

	GSM850	GSM900	GSM1800	GSM1900
Center frequency	836.6MHz	897.4MHz	1747.8MHz	1880MHz
Frequency span	Zero-span	Zero-span	Zero-span	Zero-span
Resolution Bandwidth	1MHz	1MHz	1MHz	1MHz
Video Bandwidth	1MHz	1MHz	1MHz	1MHz
Sweep Time	1ms	1ms	1ms	1ms
Trigger Type	Video	Video	Video	Video
Video trigger level	Target pwr – 10dB	Target pwr – 10dB	Target pwr – 10dB	Target pwr – 10dB
Trace Type	Clear/Write	Clear/Write	Clear/Write	Clear/Write
Detector Type	Max Peak	Max Peak	Max Peak	Max Peak
Reference Level	Target power level + 10dB	Target power level + 10dB	Target power level + 10dB	Target power level + 10dB
Internal Attenuation	Target power level + 10dB	Target power level + 10dB	Target power level + 10dB	Target power level + 10dB

In Phoenix, select Tuning → TX Power Level Tuning

Figure 21: Phoenix menu select (Tx Power Level Tuning menu)



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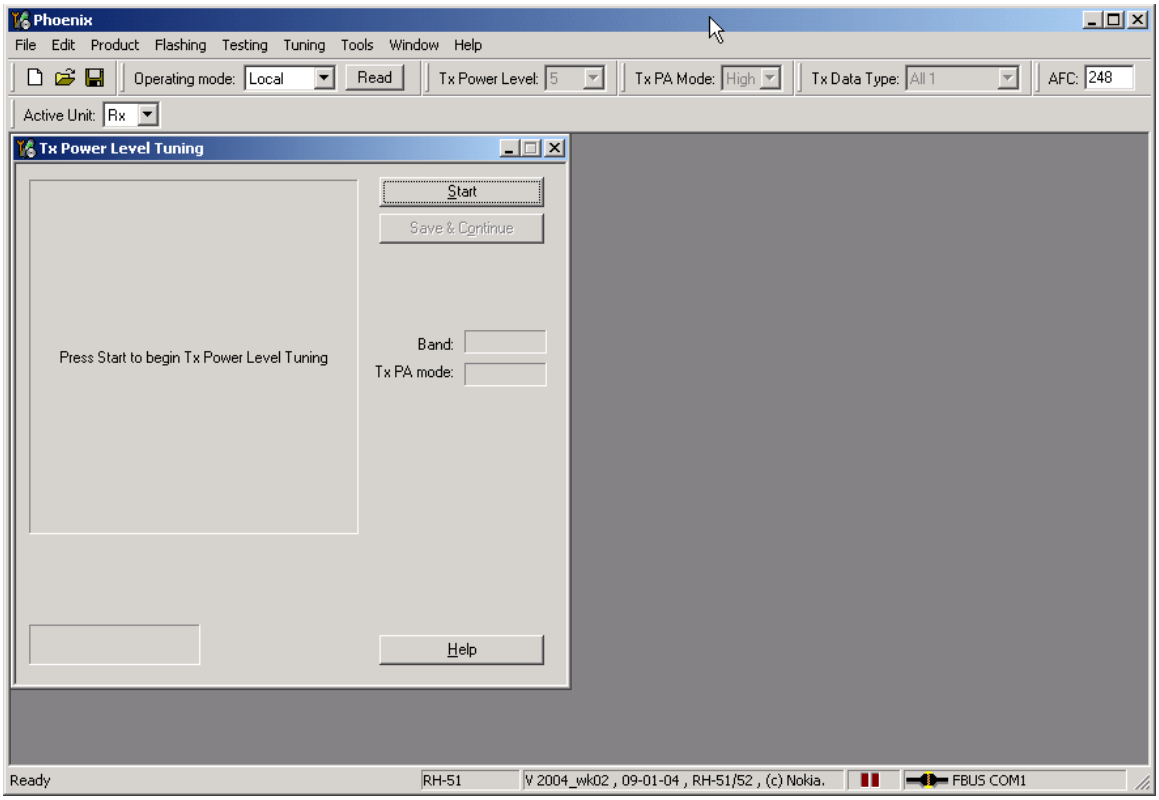
Phoenix should now look similar to the figure below.

Figure 22: Phoenix Power Level Tuning menu



Connect the module jig RF output to the measurement instrument. The power must be tuned in only high TX PA mode in all bands of GSM850, GSM900, GSM1800 and GSM1900.

For each band, tune the power by adjusting the coefficient in the 'Tx Power Level Tuning' window in Phoenix until the target level is reached (measured on the spectrum analyzer). Remember to take into account the external power loss, i.e. the loss of the cable and the external attenuator at the spectrum analyzer input.

The coefficient must be tuned for the base level and other levels marked with bold letters in Phoenix (GSM850/GSM900: PL19 / 15 / 5, GSM1800/1900: PL15, 11, 0). The target power levels are specified as listed in the following table:

Table 4: Spectrum analyzer settings for Tx level tuning

GSM850		GSM900		GSM1800		GSM1900	
LV5	32.5dBm	LV5	32.5dBm	LV0	30.0dBm	LV0	30.0dBm
LV15	13.0dBm	LV15	13.0dBm	LV11	8.0dBm	LV11	8.0dBm
LV19	5.0dBm	LV19	5.0dBm	LV15	0.0dBm	LV15	0.0dBm
Base	-27.0dBm	Base	-27.0dBm	Base	-27.0dBm	Base	-27.0dBm

When the tuning for the levels marked with bold letters has been completed, press 'Cal-

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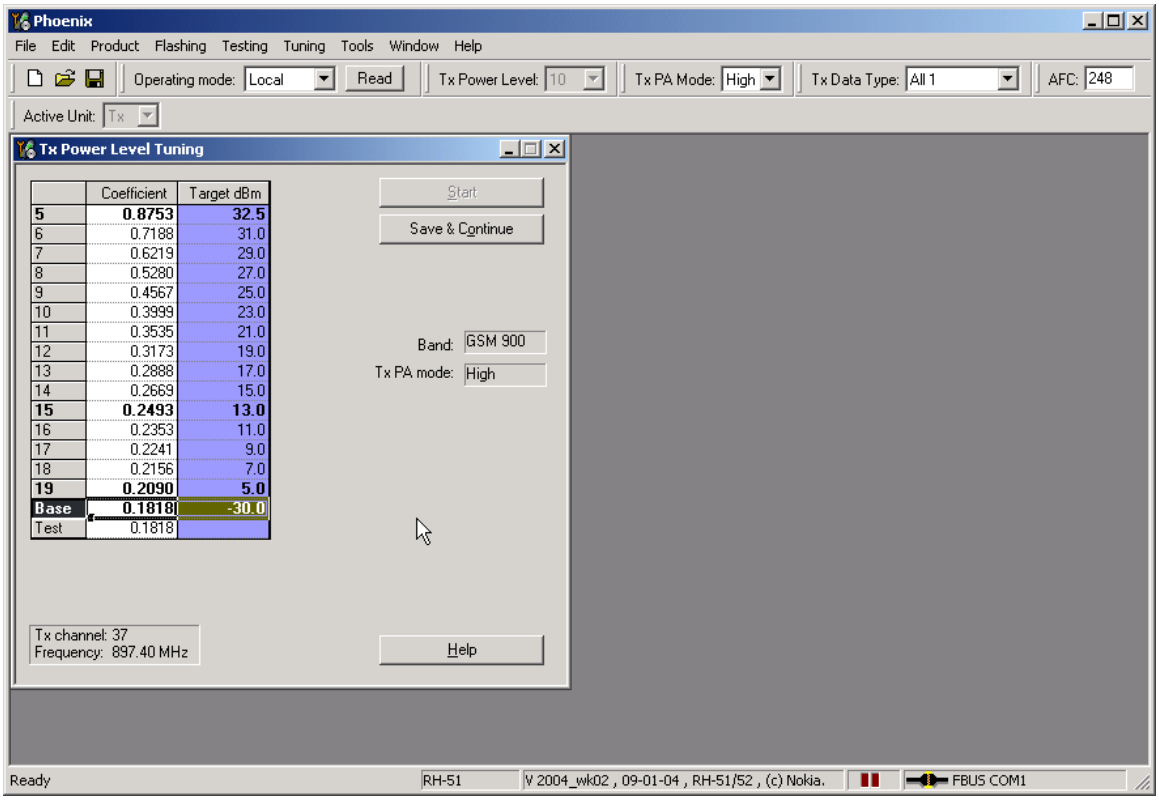
culate coefficients' to calculate the other power levels with non-bold letters.

When the coefficient calculation was done successfully, then press 'Save & Continue' to save the new tuning values into the phone memory.

The following figure shows the power level tuning at the GSM900 band.

Figure 23: Phoenix screen shot (Tx Power Level Tuning)



The figure below shows one example from the spectrum analyzer screen during measuring the Tx power level.

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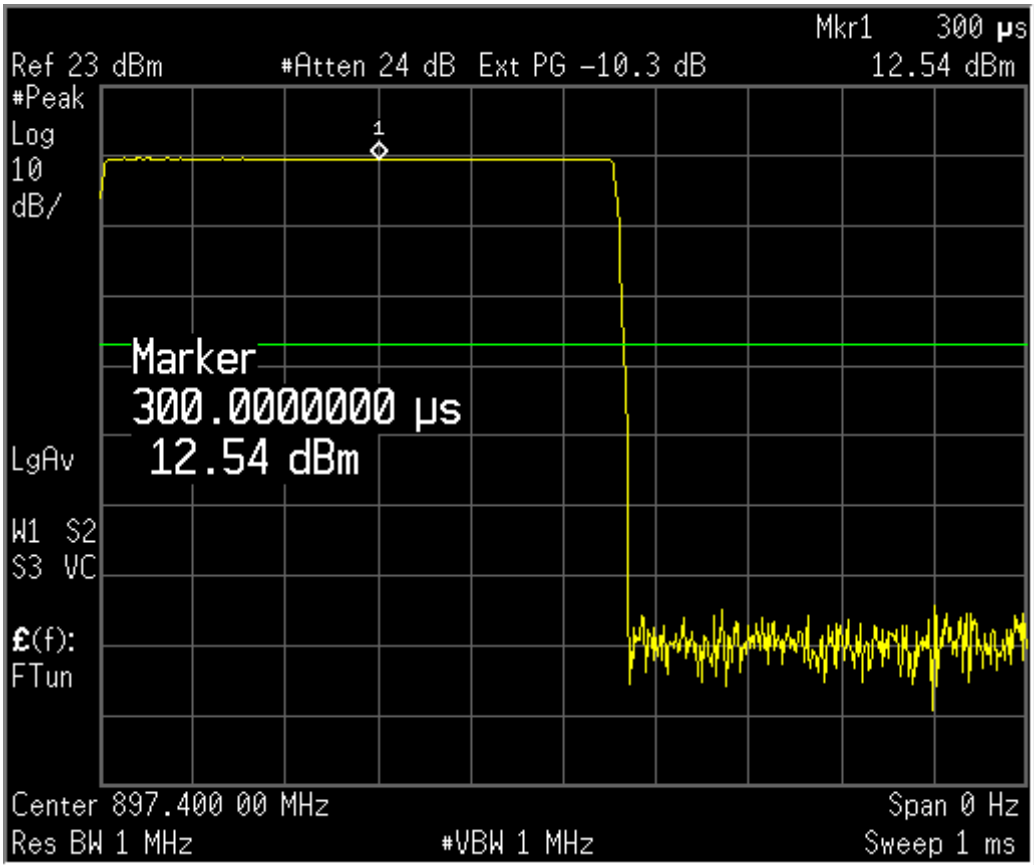
Figure 24: Spectrum analyzer screen shot during power level tuning



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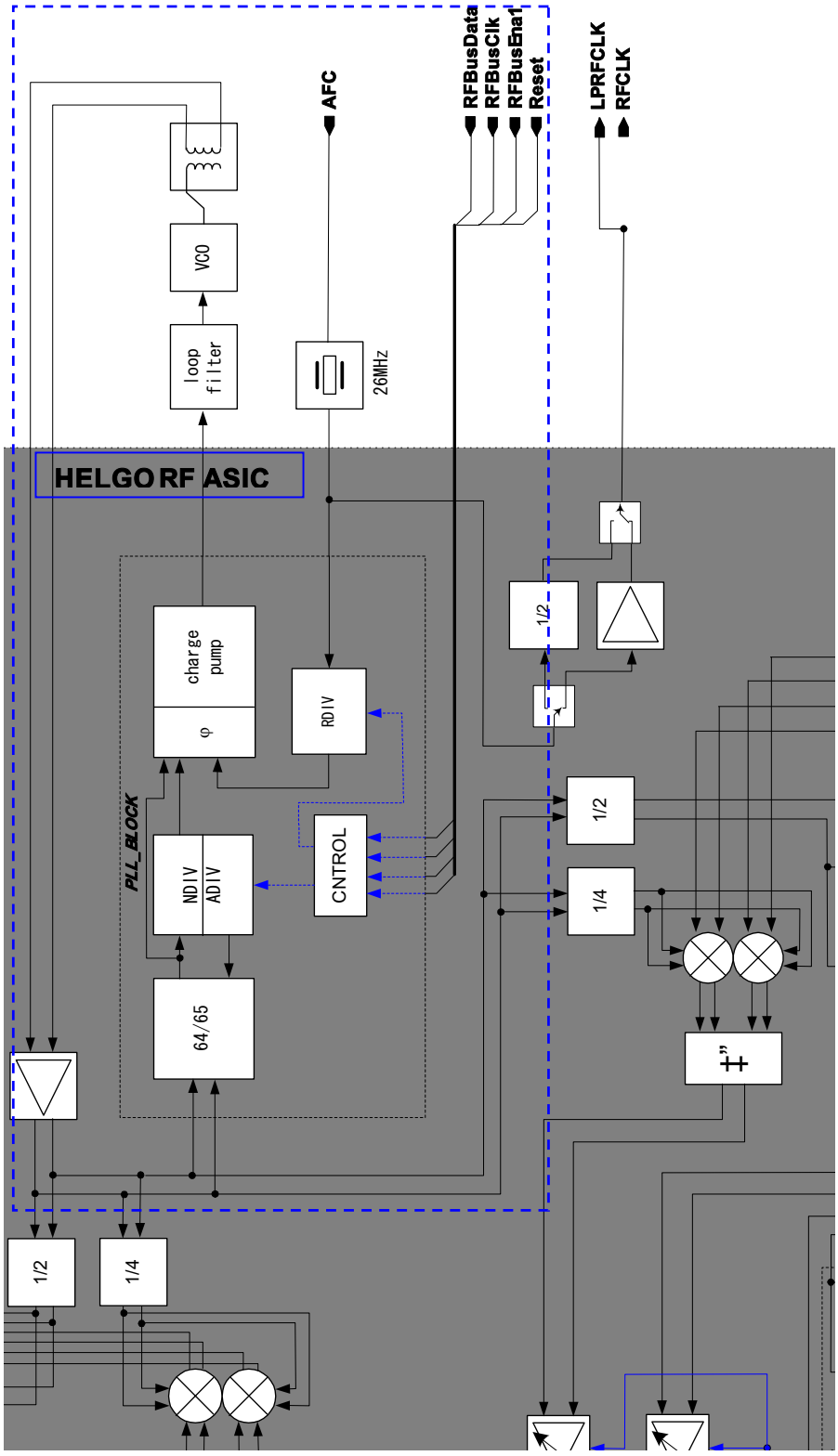
Synthesizer troubleshooting

General description

Figure 25: Synthesizer block diagram



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The PLL is capable of tuning frequency range for GSM band 850/900/1800/1900. Hence PLL is common in all variants.

The VCO frequency is locked by a PLL (phase locked loop) into a stable frequency source given by a VCTCXO, which is running at 26 MHz. The frequency of the VCTCXO is in turn locked into the frequency of the base station with the help of an AFC (automatic frequency control) voltage, which is generated in UEME by an 11-bit D/A (digital-to-analog) converter.

The PLL is integrated in Helgo and it is controlled through the RFBus. The PLL consists of a 64/65 (P/P+1) prescaler, N- and A-divider, reference divider, phase detector and a charge pump for the external loop filter. The 4 GHz oscillator signal, generated by the VCO, is fed through a 180 degrees balanced phase shifter to the prescaler and the output of the prescaler is fed to the N- and A-divider, which produces the input to the phase detector. The phase detector compares this signal to the reference signal, which is divided by the reference divider from the VCTCXO frequency. The frequency of the reference signal is 400 kHz. The output of the phase detector is connected to the charge pump, which charges or discharges the integrator capacitor in the loop filter depending on the phase of the measured frequency compared to the reference frequency. The integrator output voltage is finally connected to the control input of the VCO. The VCO operates at the channel frequency multiplied by two in DCS1800/PCS1900 and by four in GSM850/EGSM900. The required frequency dividers for modulator and demodulator mixers are integrated in Helgo.

Loop filter filters out the comparison pulses of the phase detector and generates a DC control voltage to the VCO. The loop filter determines the step response of the PLL (settling time) and contributes to the stability of the loop. Other filter components are for sideband rejection. The dividers are controlled via the RFBus. RFBusData is for the data, RFBusClk is a serial clock for the bus and RFBusEna1X is a latch enable, which stores the new data into the dividers.

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Figure 26: RF key component.

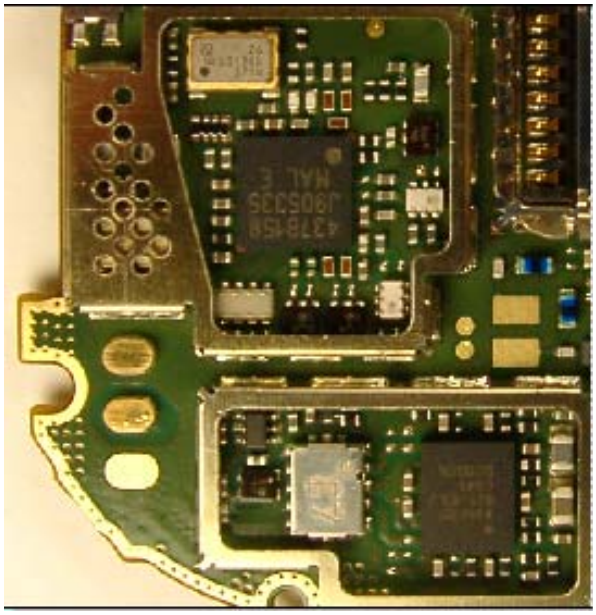
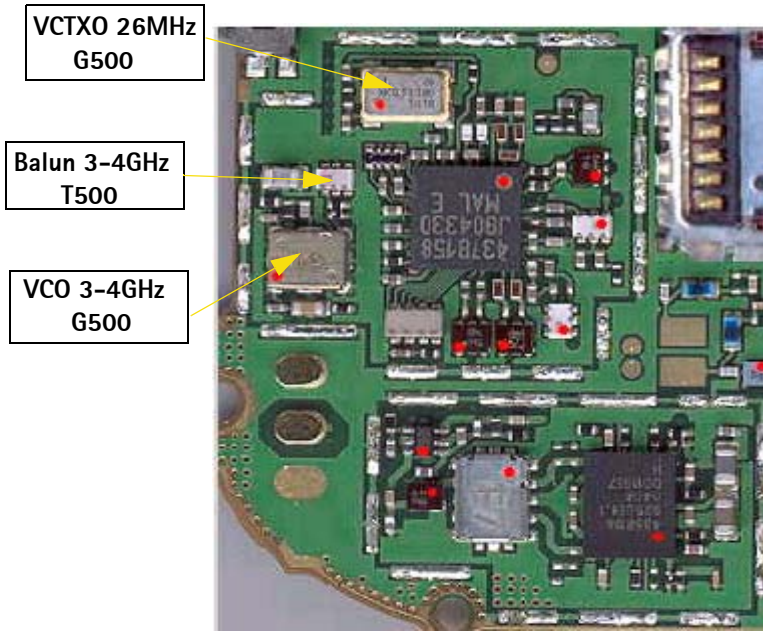


Figure 27: Synthesizer key components without shielding frame



Assumption

No failure i.e. soldering or component failure for simple SMD components such as resistors, inductors and capacitors.

Failure in one particular operating GSM channel whether Tx or Rx in which the synthesizer is the cause of the failure, all other GSM channel in Tx/Rx should fail.

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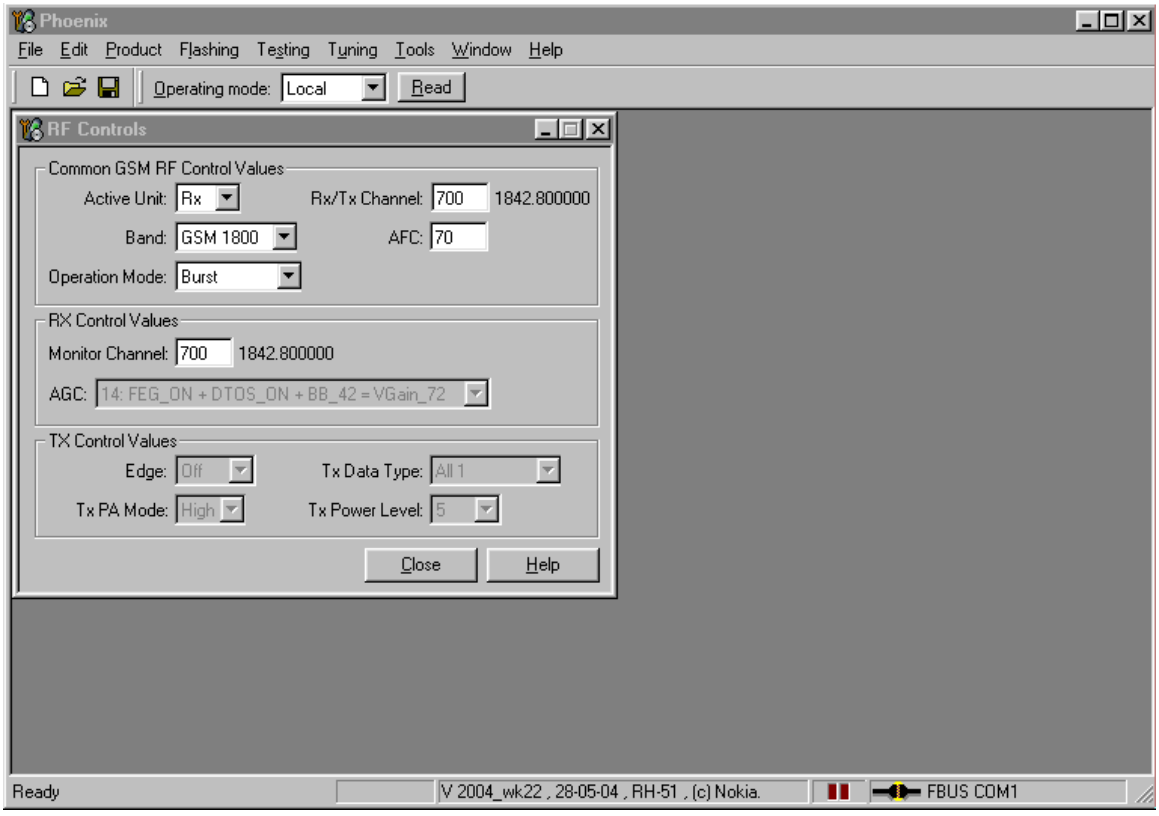
Preparation for troubleshooting

- Place the phone (mechanics removed) on module jig.
- Connect the module jig to the PC via a DAU-9P cable.
- Connect the module jig to a power supply (4.2V).
- Connect the RF output to a spectrum analyzer or another measurement instrument.
- Use a 10dB attenuator at the input to spectrum analyzer to avoid damage.
- Make sure the dongle is connected and start Phoenix.
- In Phoenix: File → Open Product → RH-51, -52, -67 or -68 Product Menu.
- Select Testing → RF Controls.
- From the toolbar: set Operating Mode to Local.
- Select band "GSM 1800".
- Set Operation Mode "Continuous".
- Set Active Unit "Rx".
- Set Rx/Tx Channel "700".

Figure 28: Preparation for troubleshooting using Phoenix – RF control setup.



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Measuring the synthesizer manually using spectrum analyzer

Spectrum analyzer level values depend on the probe type and should be validated using a known good sample. The levels that are given here are measured using a high frequency probe. Spectrum analyzer should be at least capable of measuring signal upto 4.5 GHz.

Troubelshooting chart for synthesizer

Figure 29: Troubleshooting chart for synthesizer

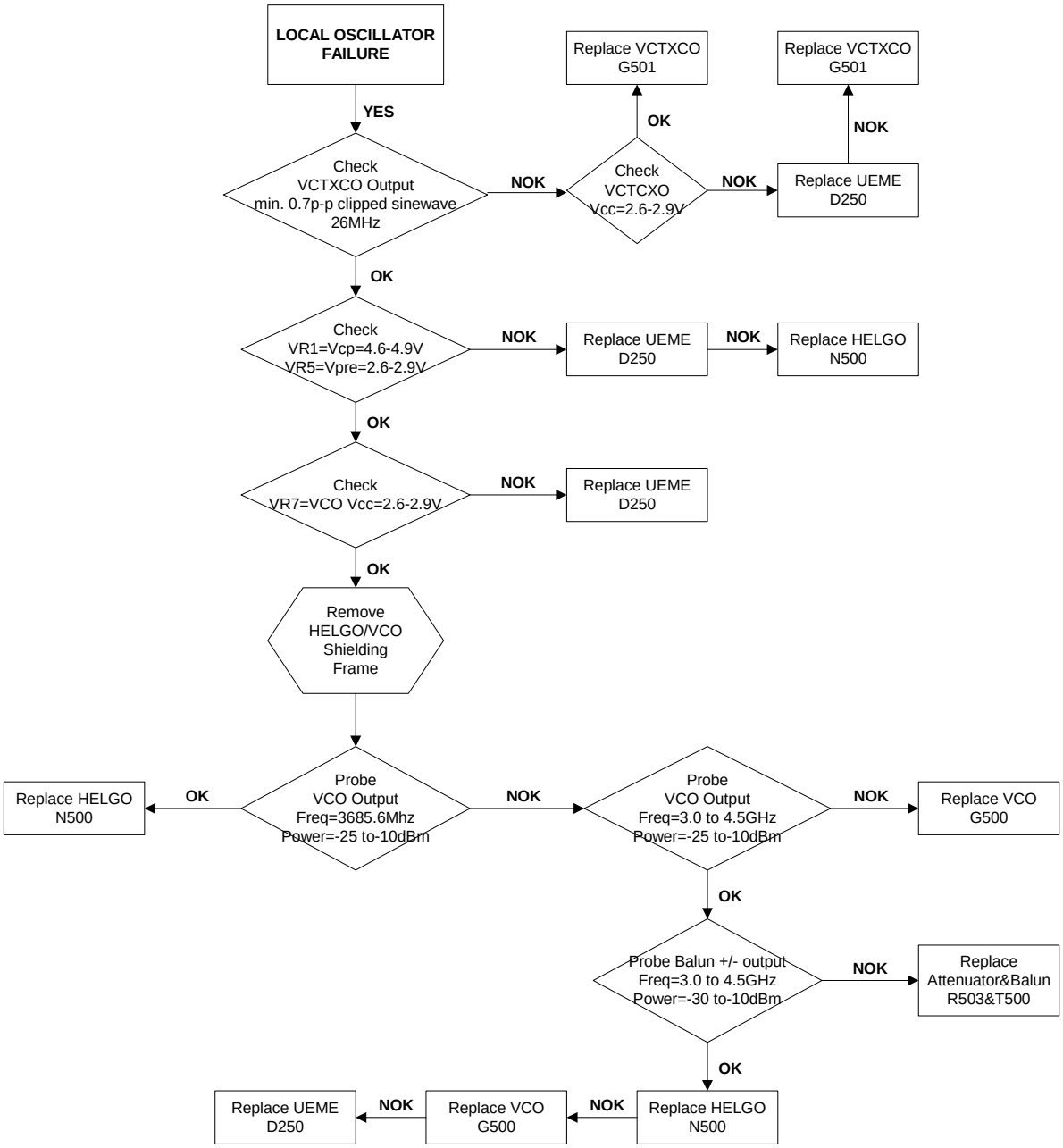

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Figure 30: Measurement points for synthesizer. Layout shows HELGO/VCO compartment.

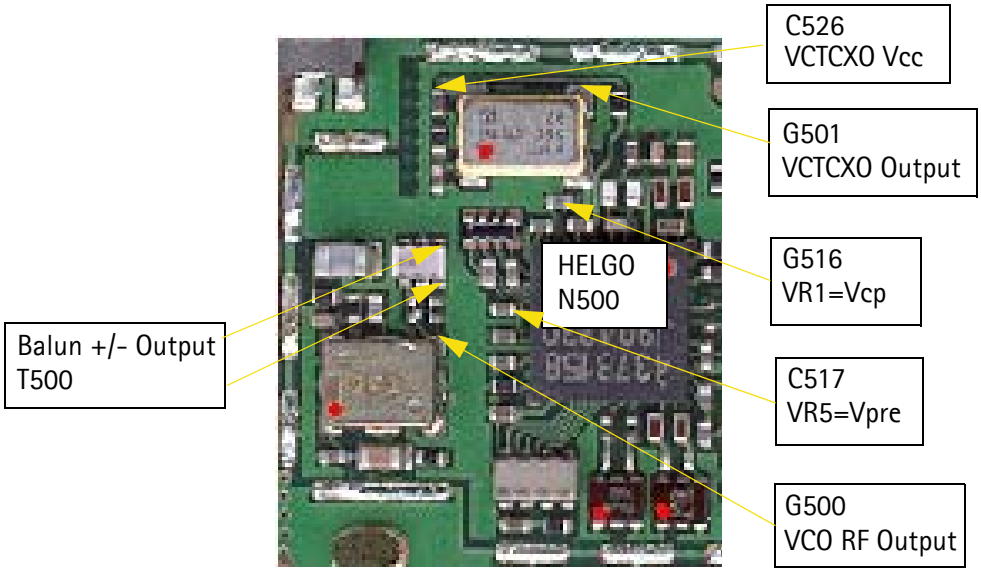
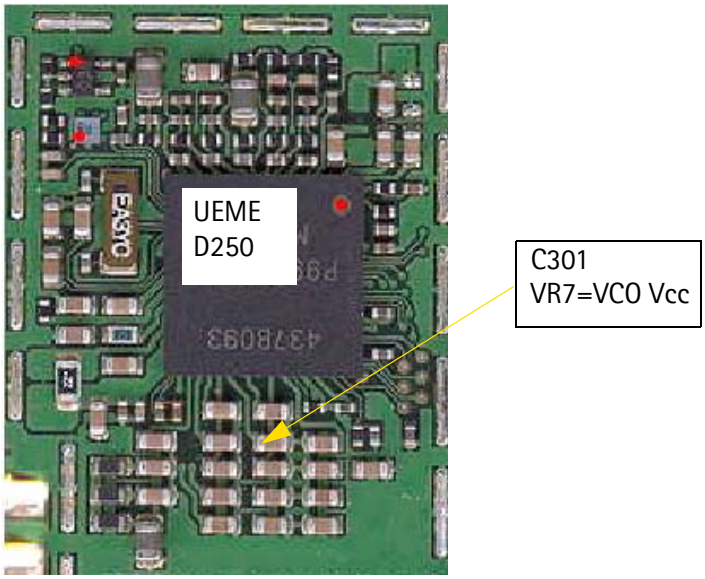


Figure 31: Measurement points for synthesizer. Layout shows UEME compartment



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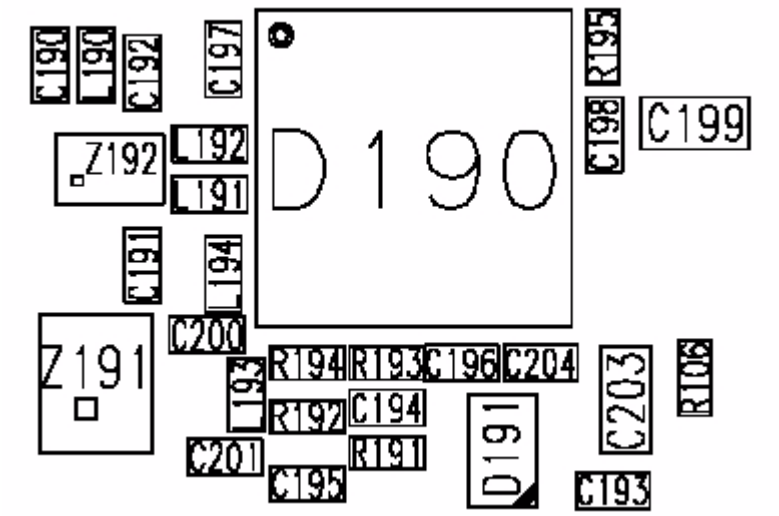
Bluetooth troubleshooting

This document describes BC02 bluetooth solution troubleshooting for Care. Applicable parts can be copied to phone products' service document. It is assumed that the main service manual includes part "How to connect Phoenix to phone".

Bluetooth component placement

Figure 32: RH-51/52, RH-67/68 Bluetooth component placement



Bluetooth settings for Phoenix

Procedure:

1 Connect phone to Phoenix in 'local' mode.

2 Select product by: File –> Scan Product.

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3 Choose: Testing –> Bluetooth LOCALS

4 Locate JBT-9's Ser.No. (12 digits from the type label) found in the type label in the back of JBT-9.

5 In the Bluetooth LOCALS setting enter Ser.No. for the "Counterpart Device Address" field. This has to be done only once provided JBT-9 is not changed.

6 Run BER test when JBT-9 box is proximity of the DUT's Bluetooth antenna. Suitable distance is approximately 10 centimeter.

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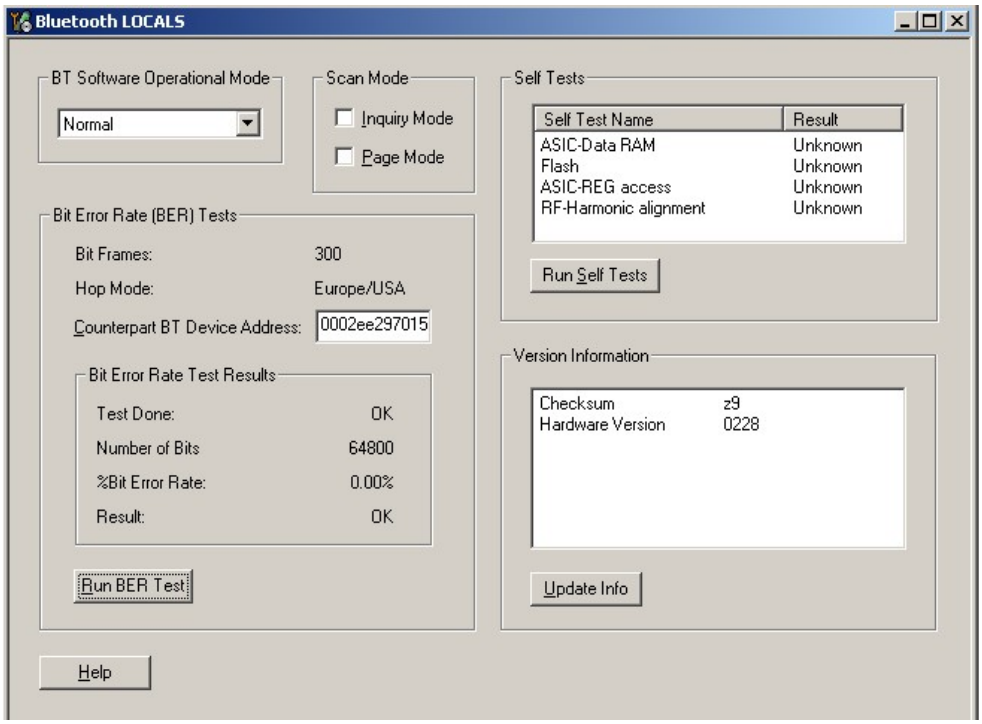
Figure 33: Phoenix settings for Bluetooth troubleshooting



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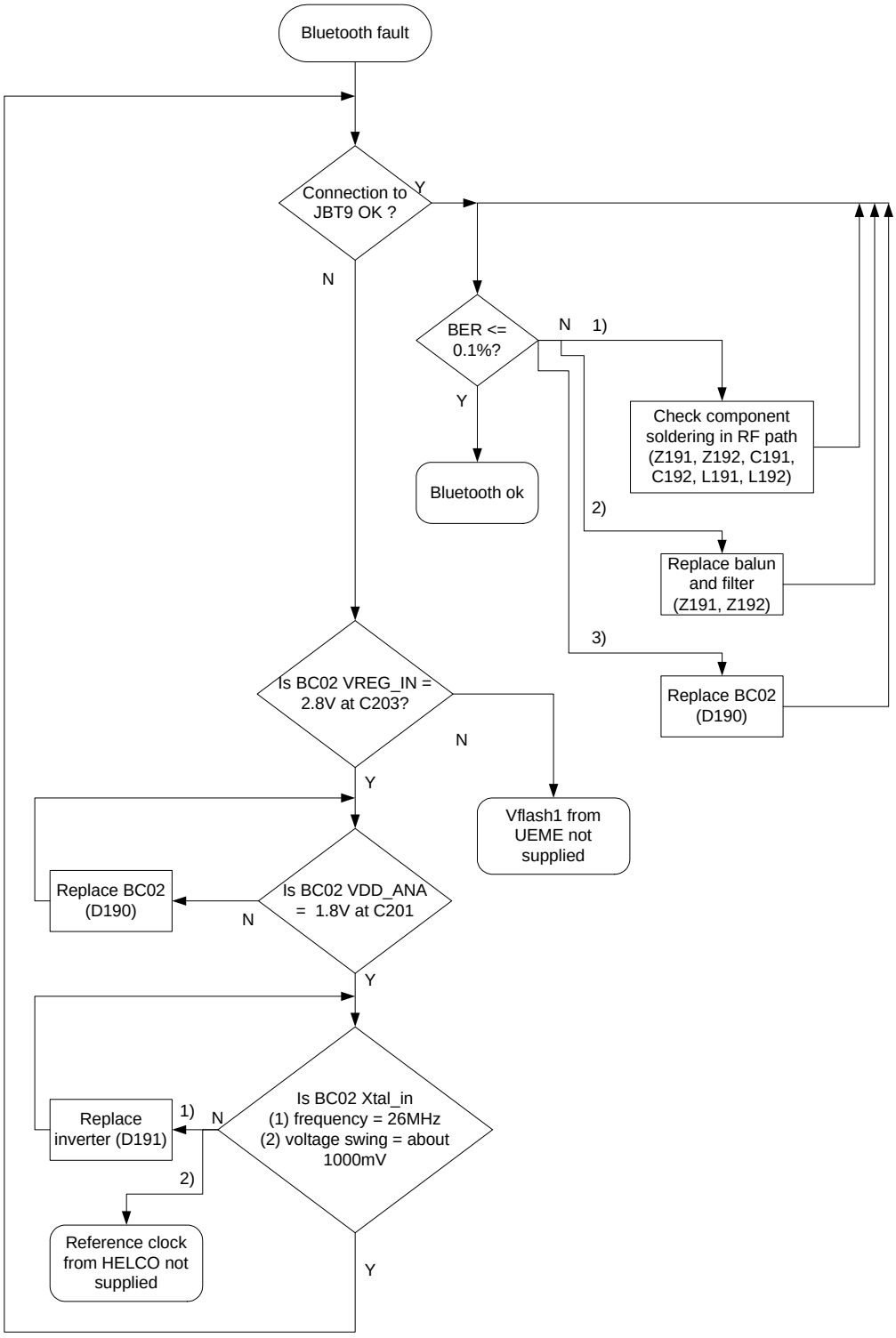
Bluetooth troubleshooting diagram

Figure 34: Bluetooth troubleshooting flowchart



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